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JAN 13 1931

Railway Mechanical Engineer

FOUNDED IN 1832

FORCING the Boiler IS Expensive

... in Fuel

... in Maintenance

TRANSPORTATION LIBRARY

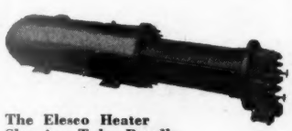
LOCOMOTIVE BOILERS can be forced beyond their rated capacity, but beyond certain limits this is expensive and results in increased maintenance.

Elesco feed water heaters avoid this expensive abuse by adding at least 15 per cent more capacity to the boiler without increasing the amount of fuel burned.

To the operating man this extra 15 per cent shows handsome returns in faster schedules when capacity is needed or a corresponding saving in fuel when this added capacity is not required.

To the mechanical officer it avoids the need of forcing the boiler and shows a worth while saving in reduced maintenance and less steam failures.

Elesco feed water heaters are readily applicable to existing locomotives.



The Elesco Heater Showing Tube Bundle Partially Withdrawn

Elesco CF Type Boiler Feed Pump

THE SUPERHEATER COMPANY

60 East 42nd Street New York

ELESCO

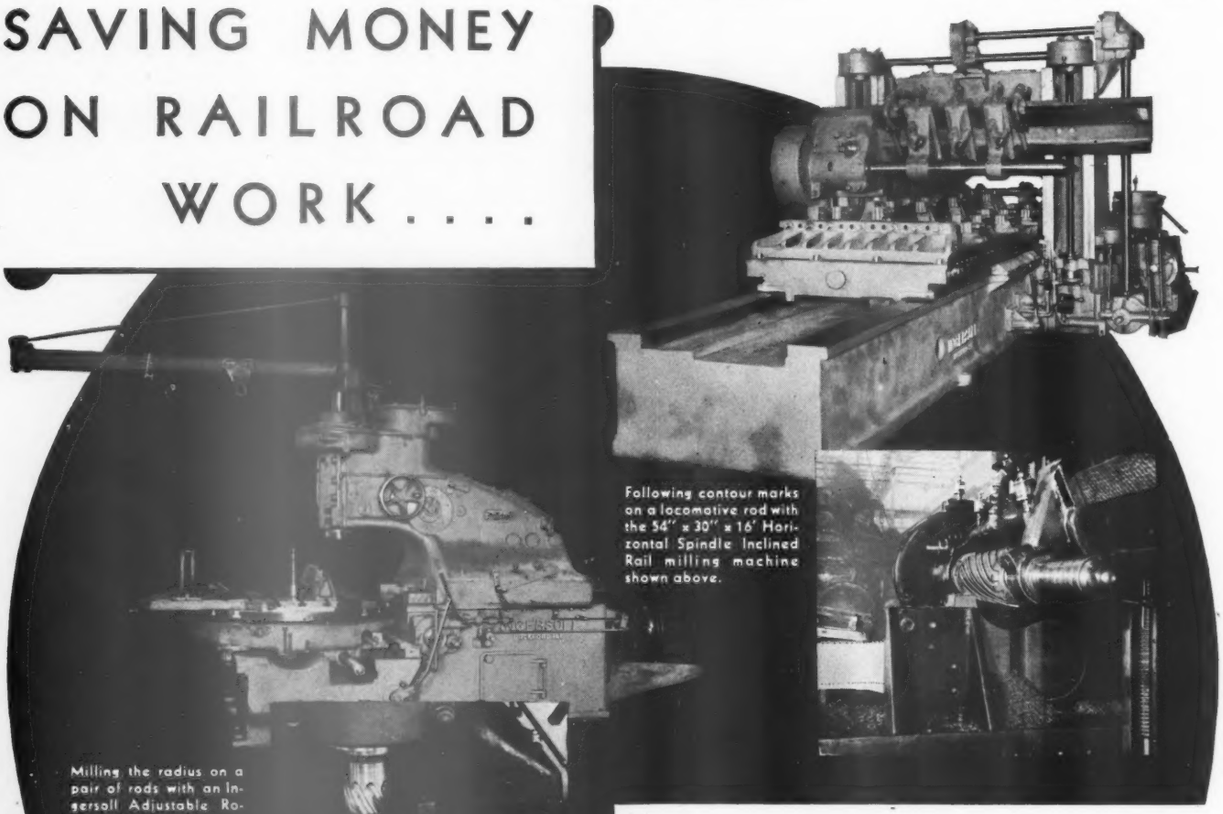
Peoples Gas Building Chicago

A552

January 1931

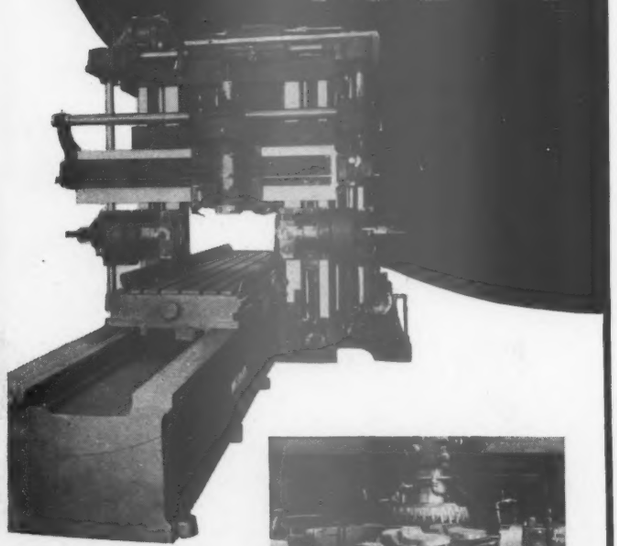
35¢

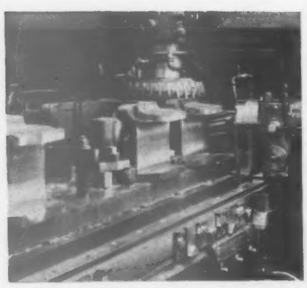
SAVING MONEY ON RAILROAD WORK . . . .



Following contour marks on a locomotive rod with the 54" x 30" x 16' Horizontal Spindle Inclined Rail milling machine shown above.

Milling the radius on a pair of rods with an Ingersoll Adjustable Rotary milling machine using a 5" x 12" Ingersoll helical cutter.





The rolls and inner face of new driving boxes are being milled on this 36" x 36" x 16', 3-head Ingersoll Adjustable Rail milling machine.

These three Ingersolls are saving money for railroad shops throughout the country. Each of these tools is easily controlled, all elements have power feed and rapid traverse and each has the built-in reserve strength needed to maintain maximum output throughout a long productive life.

The Inclined Rail milling machine, in sizes to suit the customer's work, is used extensively for slabbing, channeling and edging locomotive rods and milling shoes, wedges and link motion parts. It is powerful and rugged enough to drive slabbing and channeling cutters to capacity without distress. Equipped with Ingersoll universal rod fixtures two large rods are held for slabbing or channeling and six for edging.

The Adjustable Rotary milling machine returns substantial dividends on such work as rod ending, milling out jaws, trepanning and contour milling. Here again Ingersoll cutters and fixtures increase the efficiency of machine and operator.

The Adjustable Rail machine is well adapted to milling driving boxes. One face, both edges and both shoe and wedge fits, including the tapers, are milled in one setting.

Send for interesting data about these machines and their use.

THE INGERSOLL MILLING MACHINE COMPANY » » ROCKFORD, ILLINOIS, U. S. A.

Vol. 105, No. 1

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January, 1931

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138 American Railroads Now Operate TIMKEN BEARING EQUIPMENT

The broad and convincing sweep of Timken Bearings throughout the railroads of the United States is shown by the number of roads operating Timken Bearing Equipped rolling stock, and the steady increase in the number of units owned by each road.

As a matter of fact, more Timken Bearings are used by the railroads of this country than any other type of anti-friction bearing.

What is the reason for this preference? What is responsible for the dominant position enjoyed by Timkens?

The answer is, the ability of the exclusive combination of Timken tapered construction, Timken positively aligned rolls, Timken-made steel and Timken precision of manufacture to fully meet every modern anti-friction necessity in all types of cars.

It means that friction is practically eliminated; that starting resistance is reduced 88%; that hot boxes are abolished; that radial loads, thrust loads or both together, in any combination, are carried and conquered; that lubrication is simplified and economized; and that maintenance costs are cut to the bone. The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN Tapered Roller BEARINGS

Railway
Mechanical Engineer

Founded in 1832 as the American Rail-Road Journal

January, 1931

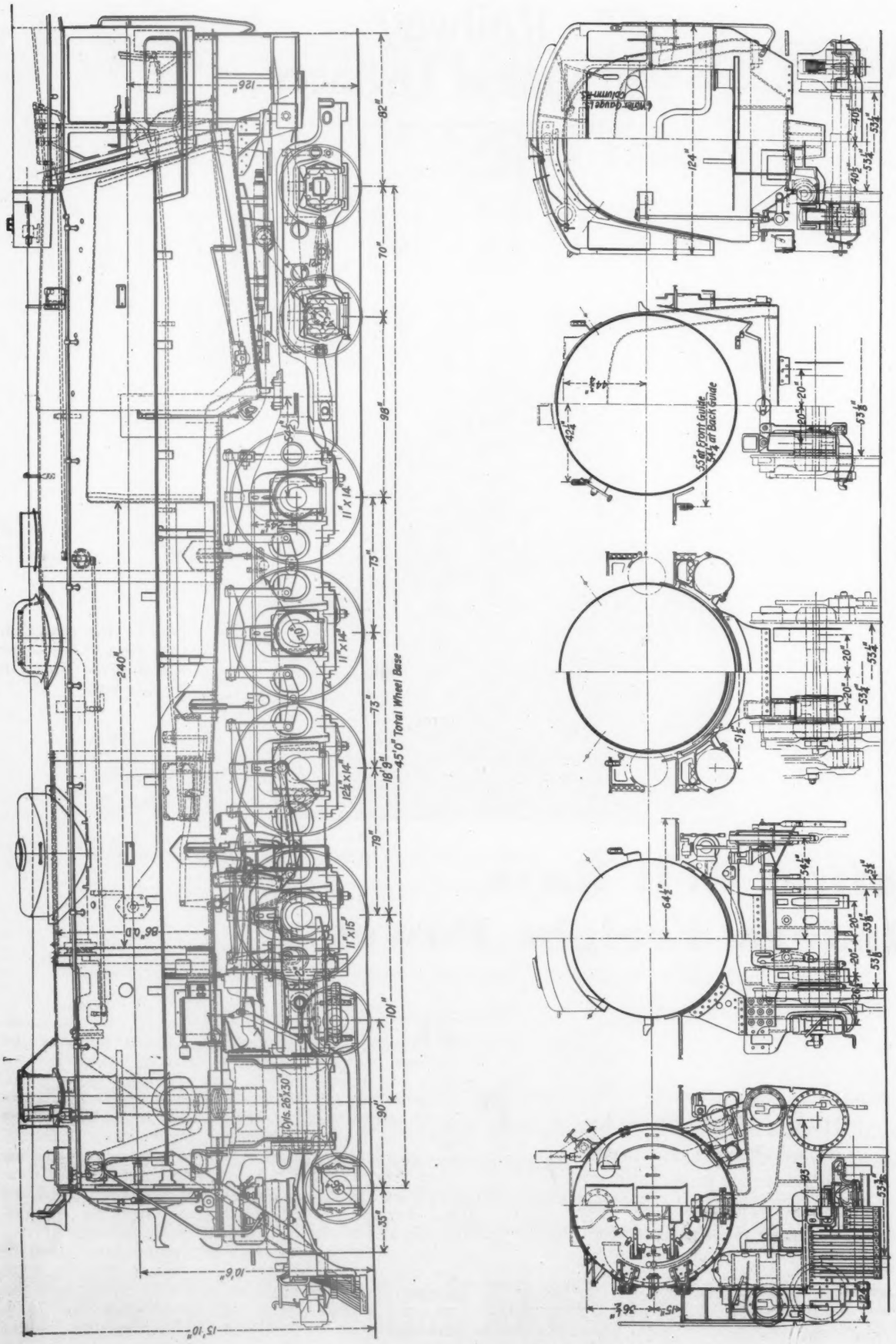
One of the new Cotton Belt 4-8-4 type locomotives just in from a run

Cotton Belt Buys Modern Freight Power

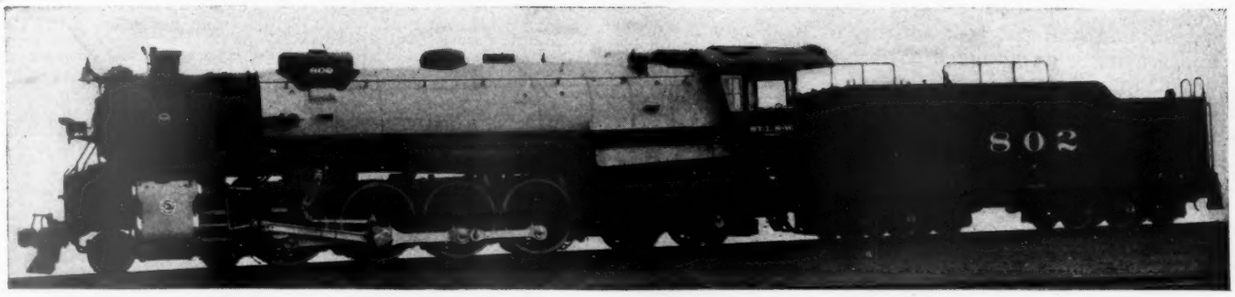
Design of 4-8-4 type has pleasing lines and promises notable performance from capacity and fuel economy standpoints

DURING the month of September, the St. Louis Southwestern placed in service a series of ten Baldwin-built, 4-8-4 type, oil-burning, steam locomotives to replace 2-8-0 type locomotives in handling the fast merchandise and perishable freight trains which comprise such a large proportion of Cotton Belt business. The new locomotives, known as the Class L-1, are used largely in main line movements between Pine Bluff, Ark., and Tyler, Tex. With a normal rated tractive force only 18 per cent greater than that of the Class K-1 locomotives replaced, they are handling approximately 30 per cent more tonnage at higher speeds.

This is expected to result in a reduction of about 20 per cent in train mileage. The new locomotives were designed with a tractive force of 61,500 lb., as great as could be had with a ratio of adhesion close to 4, considering the loading permissible on existing bridges



Elevation and cross-sectional views of the Cotton Belt 4-8-4 locomotives



Cotton Belt freight locomotive built by Baldwin

and other roadway structures. (Two steel bridges were replaced with new and heavier structures so as not to limit unduly this feature of the design.) As a portion of the territory over which the locomotives are operated is of undulating character with ruling grades of 1.2 per cent, 7,000 ft. long, it was necessary to provide large boiler capacity in order to negotiate these grades at the minimum desired speed of 15 m. p. h. The use of a four-wheel trailing truck was decided on in order to carry the greater part of the increased boiler weight. In order to provide for operation over track having a maximum curvature of 16 deg., the Alco lateral motion device was used on the front pair of driving wheels, thus keeping the length of the rigid wheel base within necessary limits. This curvature requirement also crowded together the rear longitudinal members of the General Steel Castings Corporation's integral frame and cylinder casting, in order to provide room for the lateral swing of the trailer truck, and the close spacing of these members in turn necessitated an innovation in design of the combustion air intakes, part of the air being taken at the rear of the cast steel fire pan at right angles to the path of the oil spray and part being taken at the front of the pan, parallel with the oil spray, both air intakes being controlled by suitable dampers operated from the cab. It was also necessary to limit the total wheel base of locomotive and tender as it was not desired to replace existing 90-ft. turntables.

Table Showing the Principal Weights, Dimensions and Proportions of the St. Louis Southwestern 4-8-4 Type Locomotives

Railroad	St. Louis Southwestern
Builder	Baldwin Loocomotive Works
Type	4-8-4
Service	Freight
Cylinders, diameter and stroke	26 in. by 30 in.
Valve gear, type	Walschaert
Valves, piston type, diameter	14 in.
Maximum travel	7¾ in.
Weights in working order:	
On drivers	242,500 lb.
On front truck	82,000 lb.
On trailing truck	98,000 lb.
Total engine	422,500 lb.
Total tender	307,000 lb.
Total engine and tender	729,500 lb.
Wheel bases:	
Driving	18 ft. 9 in.
Rigid	12 ft. 2 in.
Total engine	45 ft. 0 in.
Total engine and tender	87 ft. 7 in.
Wheels, diameter outside tires:	
Driving	70 in.
Front truck	36 in.
Trailing truck	43 in.
Journals, diameter and length:	
Driving, main	12½ in. by 14 in.
Driving, front	11 in. by 15 in.
Driving, others	11 in. by 14 in.
Engine truck	Roller bearing
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Conical
Steam pressure	250 lb.
Fuel, kind	Oil
Diameter, first ring, outside	86 in.
Firebox, length and width	132⅛ in. by 96¼ in.
Combustion chamber, length	54 in.
Tubes, number and diameter	52—2¼ in.
Flues, number and diameter	200—3½ in.
Length over tube sheets	20 ft.
Grate area	88.3 sq. ft.
Heating surfaces:	
Firebox	258 sq. ft.
Combustion chamber	104 sq. ft.
Thermic syphon	107 sq. ft.
Tubes and flues	4,259 sq. ft.
Total evaporative	4,728 sq. ft.
Superheating	2,060 sq. ft.
Combined evap. and superheating	6,788 sq. ft.
Tender:	
Style	Water-bottom, riveted and welded
Water capacity	15,000 gal.
Oil capacity	5,000 gal.
Rated maximum tractive force	61,500 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	57.3
Weight on drivers ÷ tractive force	3.94
Total weight engine ÷ combined heating surface	62.2
Boiler proportions:	
Tractive force × diameter drivers ÷ comb. heat. surface	634
Comb. firebox heat. surface ÷ grate area	5.31
Comb. firebox heat. surface, per cent of evap. heat. surface	9.92
Superheating surface, per cent of evap. heat. surface	43.6
Tractive force ÷ comb. heat. surface	9.07

Silico-Manganese Steel Used in Boiler

Silico-manganese steel, having a minimum ultimate strength of 70,000 lb. per sq. in., was furnished by the Lukens Steel Company for the boiler shell and outside firebox wrapper sheets, thus permitting the use of thinner sheets and a corresponding increase in size of boiler without exceeding the weight limitations. This steel compares with carbon steel of 55,000 lb. per sq.

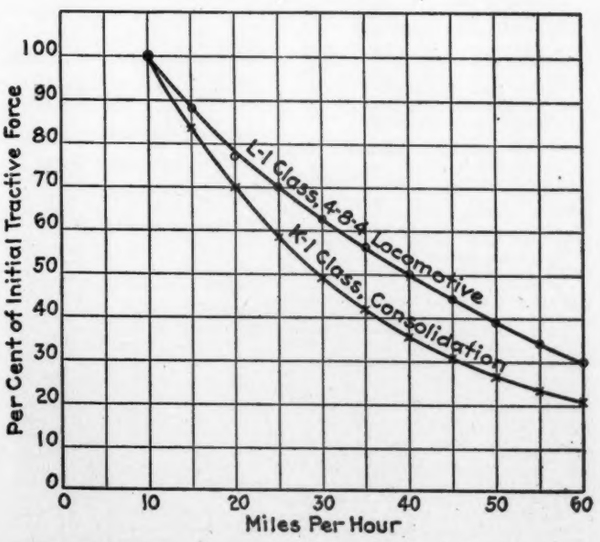


Chart showing marked superiority of the new L-1 locomotives in per cent of initial tractive force developed at speeds, owing to the provision of ample boiler capacity

in. ultimate strength, as commonly used. Boiler staying and bracing were designed so that the maximum stress on all firebox stays did not exceed 6,550 and on braces 8,000 lb. per sq. in. The boiler was built for a working pressure of 250 lb. per sq. in., this pressure being decided on as being the middle ground between lower, less efficient pressures and somewhat more efficient higher pressures, with the possibility of the increased efficiency being offset by increased boiler maintenance. The use of 250 lb. steam pressure instead of 200 lb. used on K-1 class improves the economy and gives a smarter locomotive with better acceleration.

The boiler is equipped with a Type E superheater which, it is estimated, permitted the following increases over what would have been possible with a Type A superheater: Tube and flue heating surface, 6 per cent; total evaporating heating surface 14.5 per cent, and sustained boiler horsepower, 27.1 per cent. Because of favorable tests previously conducted by the St. Louis Southwestern on Class K-1 locomotives, the L-1 class was also equipped with a feedwater heater and Thermic syphons. The Worthington Type S heater was used, although the tests were conducted on the older Type BL heater and indicated that approximately 15 per cent of the water used was recovered, with a fuel saving of 6 to 15 per cent, depending on the load factor and the operating conditions. Three Nicholson thermic syphons were applied, two in the firebox and one in the combustion chamber, as previous tests are said to have indicated fuel savings up to 13 per cent on K-1 class, equipped with only two syphons in the firebox. The use of the American front end throttle permits the delivery of the steam to the cylinders by a short route and makes superheated steam available almost at the instant the throttle is opened. With the Type E superheater covering almost the entire area of the tube sheets, it is impracticable to install a superheater damper; therefore, to maintain some circulation through the superheater, superheated steam is used for more auxiliaries than would be the case if economy only were considered. The L-1 class uses superheated steam for the air compressors, hot- and cold-water pumps, dynamo, oil-burner atomizer and blow-back, blower and whistle.

While the nominal rated tractive force of the L-1 class, 61,564 lb., is approximately 18 per cent greater than the K-1 class, it is contemplated that the L-1 class will handle approximately 30 per cent more tonnage at a higher speed and without excessive speed on the descending grades. Owing to the capacity of the boiler, the initial starting effort does not drop off so rapidly at speed, this being shown in the chart. The maximum

Special Equipment and Appliances on the St. Louis Southwestern 4-8-4 Type Locomotives

Railroad	St. Louis Southwestern
Builder	Baldwin Locomotive Works
Service	Freight
No. built	10
Firebox and boiler:	
Shell steel, silico-manganese	Lukens Steel Company
Firebox steel, open-hearth carbon	Lukens Steel Company
Back-pressure and steam gages	Ashton Valve Company
Blow-off cocks, narrow-clearance type	The Bird-Archer Company
Boiler checks	Edna Brass Company
Boiler brace iron	Logan Iron & Steel Co.
Feedwater heater, Type S	Worthington Pump & Machinery Corp.
Fire brick, Arch-lock type	American Arch Company
Fire-brick cement	Johns-Manville Company
Flexible joints for air connections to power reverse gear, main reservoir, brake cylinders, etc., and for steam connections to headlight dynamo	Barco Manufacturing Company
Flexible staybolt iron (Alco-type bolts)	Logan Iron & Steel Co.
Gage cocks, Renu-type	Sargent Company
Injector, Hancock 8,000-gal. capacity	Consolidated Ashcroft-Hancock Co.
Jacket, 18-gage cold-rolled picked steel (Minimum copper content, .20 per cent)	American Sheet & Tin Plate Co.
Lagging	Johns-Manville Company
Oil burner, Von-Boden-Ingles type	E. S. Sullivan Company
Pipe covering	Johns-Manville Company
Pyrometer	The Superheater Company
Rivets, Victor	Champion Rivet Company
Safety valves (1 muffle; 2 open)	Consolidated Ashcroft-Hancock Co.
Smokebox hinges	Okadee Company
Staybolt iron for rigid bolts and radial stays (rigid bolts hollow drilled)	Penn Iron & Steel Co.
Steam-pipe casing, Flextite type	American Locomotive Company
Superheater, Type E	The Superheater Company
Thermic syphons (2 in firebox; 1 in combustion chamber)	Locomotive Firebox Company
Throttle, American multiple-type	American Throttle Company
Tubes and flues	National Tube Company
Washout plugs	Huron Manufacturing Company
Water columns and reflex water glasses	Edna Brass Company
Whistle, steam	Consolidated - Ashcroft - Hancock Co.
Whistle blower, pneumatic	Davis-Lampton Company
Cylinders and Running Gear:	
Cylinders and bed frame, cast integral	General Steel Castings Corp.
Cylinder and valve bushings, Eddystone B iron	Baldwin Locomotive Works
Cylinder packing rings, Duplex sectional	Hunt-Spiller Company
Valve packing rings, Eddystone B iron	Baldwin Locomotive Works
Cylinder and valve head casings, chromium plated	
Cylinder cocks and automatic drain valves	Okadee Company
Drifting valves, Chicago automatic type	Ohio Injector Company
Driving and trailing tires, heat-treated	Midvale Steel Company
Flange oiler, for front driving wheels	Detroit Lubricator Company
Foundation brake gear	American Brake Company
Lateral motion device front drivers	American Locomotive Company
Lubrication for all rods, valve motion, etc., Alemite	Prime Manufacturing Company
Main driving-box bearings, Grisco-type	Gill Railway Supply Company
Hydrostatic lubricator, three-feed	Nathan Manufacturing Company
Mechanical lubricator, Schlacks	U. S. Metallic Packing Company
Pedestal wedges, adjustable	Franklin Railway Supply Company
Piston rod and valve stem packing, King type	U. S. Metallic Packing Company
Power reverse gear, Type G	American Locomotive Works
Radial buffer	Franklin Railway Supply Company
Rods, axles, guides, crank pins (Medium Class B, annealed carbon)	Standard Steel Works
Safety bar	Franklin Railway Supply Company
Springs, elliptic	Railway Steel Spring Company
Spring bands, cast steel	Standard Brake Shoe & Fdy. Co.
Springs lubricated when made with No-Ox-Id	Dearborn Chemical Company
Trailer-truck frame, cast steel (Arranged for future booster application)	General Steel Castings Corp.
Trailer truck cellars, Alco type	American Locomotive Company
Valves	Consolidated Ashcroft-Hancock Co. and Walworth Co.
Wheel centers, manganese steel	Standard Steel Works
Engine-truck bearings, roller type (5 locos.)	Timken Roller Bearing Company
(5 locos.)	SKF Industries, Inc.
Cab and Miscellaneous:	
Air gage, Quadruplex	Ashton Valve Company
Bell ringer, internal type	Transportation Devices Corp.
Brake valves mounted on sloping type pedestal	Westinghouse Air Brake Company
Cab curtains and awnings, Mule-Hide	Lehon Company
Cab windows, clear vision and storm	Prime Manufacturing Company
Cab side ventilators	Prime Manufacturing Company
Headlight, generator and classification lamps (Oliver type wiring fixtures)	Pyle-National Company
Lock nuts	Grip Nut Company
Paint, Opex lacquer	Sherwin-Williams Company
Sanders, triple type	Viloco Railway Equipment Co.
Speed indicator and recorder, Boyer type	Chicago Pneumatic Tool Company
Wire in conduit	Okonite Company
Wire in cab drops	General Electric Co.
Tender:	
Frame, Commonwealth water-bottom type	General Steel Castings Corp.
Tank, riveted, interior coated with No-Ox-Id	Dearborn Chemical Company
Truck brakes, Simplex clasp type	American Steel Foundries Company
Draft gear, Type A-78-XB	W. H. Miner, Inc.
Draft-gear attachments, Farlow	Symington Company
Draft key retainers, Sure-Lox	Western Railway Equipment Company
Dust guards, Security type	Western Railway Equipment Company
Truck journal boxes (Torsion-type lids)	Symington Company
Forged steel wedges, Top Notch	Railway Devices Company
Engine and tender connections (Oil, steam and air)	Barco Manufacturing Company

horsepower output is at least 50 per cent greater than that of the K-1 class, while at 15 m. p. h. it is practically 30 per cent greater.

Anticipated Decrease of 15 Per Cent Unit Fuel Consumption

It is expected that with a reasonably high load factor it will be possible to produce 1,000 g.t.m. with 7.42 gal. of fuel oil as against 8.73 gal. with the K-1 class. This means a decrease in unit fuel consumption of 15 per cent.

The tender is built on a General Steel Castings Corporation cast steel, water-bottom tender frame which utilizes space previously wasted, lowers the center of gravity for a stated capacity and reduces maintenance on account of the elimination of the bottom sheet of the tank and the wood decking formerly used. The tender capacity of 15,000 gal. of water and 5,000 gal. of fuel oil necessitated the use of six pairs of wheels. It is estimated that this capacity will permit operating a maximum distance of 84 miles without taking water and 330 miles without refueling. With water and fuel stations as now located, it is estimated that this tender capacity will eliminate three stops for water, one stop including refueling, on each trip over the 355-mile division on which the L-1 class will operate. The tender trucks are of one-piece cast steel construction, as are the locomotive trailer and leading trucks. Five of the engine trucks are equipped with Timken roller bearings and five with S. K. F. roller bearings, which is a new departure in the Cotton Belt territory.

Cylinders of 30-in. stroke were decided upon, due to the better tractive force curve than for a longer stroke; also on account of some expected decrease in maintenance because of lower piston speed. The Walschaert type valve gear is used, having a maximum travel of 7¾ in. and a maximum cut-off of 87 per cent. The power reverse gear is of the Alco type.

In addition to using high-tensile material for the boiler, other items of weight reduction, made use of in order to increase the weight available for the boiler, included hollow-bored driving axles and main crank pins. The main driving boxes are equipped with Grisco bearings, furnished by the Gill Railway Supply Company. Franklin adjustable wedges are used on all driving wheels.

The crossheads and the driving and trailer wheel centers, are made of high tensile manganese steel, the driving and trailer wheels being fitted with heat-treated tires. The driving wheels, being 70 in. in diameter over tires with 62-in. diameter centers, permitted satisfactory counterbalancing. The main wheels are cross-balanced. All of the revolving weights are balanced in each wheel, together with the desired amount of overbalance for reciprocating parts. The unbalanced reciprocating weight per 1,000 lb. total weight of the locomotive is 3.34 lb. and the static plus dynamic augment loading at diameter speed will not exceed the corresponding total for similar locomotives now in service.

The Class L-1 locomotives are provided with copper-bearing steel for piping and jackets; Alemite lubrication for 211 bearings; forged-steel valves for 400 lb. pressure and 750 deg. F. superheated steam and two Westinghouse cross-compound air compressors.

Various devices in the cab have been located so that the enginemen can conveniently operate them and the comfort of the crew has been well provided for by the installation of comfortable seats with arm rests, lockers and racks for supplies, tools and extra clothing; first-aid kit; clear-vision and storm windows; cab awnings and curtains; a radiator for heating the cab in cold weather, and five adjustable ventilators for warm weather; also the usual electric lights and ice water container.

Symmetrical Design and Lacquer Finish Give Attractive Appearance

The Cotton Belt management believes that a locomotive, neat and attractive in appearance, is a desirable asset. Therefore, the design provides for a symmetrical stream line appearance with straight running boards, hand rails and throttle rigging, as free from miscellaneous appliances, piping and other details as possible, although due consideration has been given to accessibility for repairs. The boiler and cylinder jackets have been finished with Sherwin-Williams lacquer in an attractive dark Nile green color. The cylinders and valve-chamber head casings are chromium plated and the main and side rods, as well as the valve gear, are polished.

The specifications for the locomotive were prepared by the mechanical engineering department who not only co-operated unusually closely with the builder, the Baldwin Locomotive Works, in working out the final details of the design to suit the special service and requirements of the customer, but supervised construction at the builder's plant.

* * *

Facilities for outbound engines at the Portsmouth, Ohio, shops, Norfolk & Western—Engine supply house, old enginehouse, toilet and new enginehouse shown at right—Ash hoists and coal hoists at left

Action of Four-Wheel Freight-Car Trucks*

By T. H. Symington

The author describes the results of a research of the operating and maintenance problems of car trucks which have resulted from increased weights, greater rigidity and high speeds.

THE vital parts of freight cars are the trucks. We are using today the same fundamental principles in freight-car-truck design that have been in use for 75 years.

Modern heavy cars, some of great rigidity, operating at very high speeds, have brought with them many operating and maintenance problems. A scientific study of these problems and means for their solution are discussed in this paper.

There being no equipment in existence with which to make a proper study of the various problems involved, it was necessary to build two standard freight cars and equip them with much special apparatus which would give exact results. Each car is also equipped with 12 water tanks to provide any desired load. The two cars were necessary in order continually to have a yardstick with which to compare the performance of different appliances.

An accurate superimposed record is made on a recording table in one of the cars of the following actions on each car:

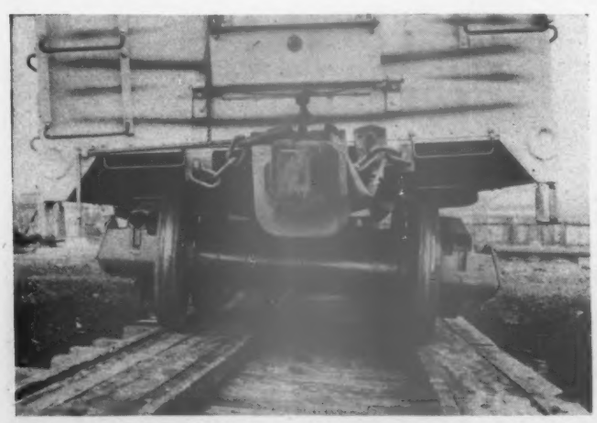
1—Speed in miles per hour.
2—All car-body roll in relation to the constant plane of Sperry gyroscopes.
3—All truck-spring movements on both sides of the leading trucks.
4—All vertical movements of the center line of each car.
5—All lateral movements between the car body and one side frame.
6—All movements, at right angles to the journals, between the journal-box wedge and the roof of the journal box.

A telemeter record is made of the magnitude and frequency of all transverse forces and of the forces of vertical acceleration resulting from spring oscillation or end shock.

Each car is also equipped with an accurate spring dynamometer with which to measure the force of vertical acceleration resulting from end shock and a Kreuger-cell instrument with which to measure both the force of vertical acceleration resulting from end shock and the same maximum force of vertical acceleration resulting from spring oscillation. Both cars are equipped with large periscopes through which to see and study all truck actions from inside the cars.

This research work naturally divides itself into four general headings, viz: Safety, Damage to Lading, Train Resistance, and Maintenance Costs. These are all so interrelated that it is thought best to discuss the truck as a whole and then in detail.

* An abstract of a paper entitled "Research Relating to the Action of Four-Wheel Freight-Car Trucks," which was presented before the Railroad Division, A. S. M. E., Tuesday afternoon, December 2, 1930. The author is president of T. H. Symington & Son, Inc., Baltimore, Md.



T. H. Symington bolster, 55-ton rigid car, with an 18-ton load—A.R.A. truck springs.

The outside rail on this 10-deg. curve is depressed to produce a track warp of 6 in. between truck centers when about 30 per cent of normal load is on the outside leading truck wheel.

The Four-Wheel Truck

Wheel sliding can be prevented only by having both axles always radial to the curve. This has never been accomplished in a simple, efficient four-wheel truck design. The only truck yet produced where the axles are always radial to the curve is the Boyden six-wheel freight-car truck.*

This wheel sliding always necessitates, on any curve, a continuous high flange pressure against the rail of the outside leading wheel. No derailment on curves will result from this particular flange pressure unless the weight on this wheel is unduly reduced.

Cross-equalization—With flexible cars, the only cause of reduced weight on this leading outside wheel is excessive car roll that may put one-half of the entire body weight on one side bearing. With rigid-body cars and reduced side-bearing clearance, track warp may also put the entire weight of one-half the car body on one side bearing 25 in. from the center. Only 15 per cent of the load is then on one side of the truck, and this sometimes is not sufficient to keep the wheel on this side from mounting the outside rail. With large side bearing clearance, excessive car roll also may result in derailments on approach curves, whether the car is flexible or rigid, because of insufficient cross-equalization of load and increased swiveling resistance resulting from excessive weight on one side bearing.

If the load on one truck never can be more than 16 in. from the center, the minimum proportion of the load on one side of the truck is about 30 per cent, which

* A description of the improved Boyden six wheel coördinating truck was published in the October, 1924, issue of the *Railway Mechanical Engineer*, page 602.

always is sufficient to keep a wheel from mounting the rail on curves from flange pressure.

The end views of the cars equipped with A. R. A. standard and T. H. Symington bolsters illustrate the two conditions—with and without cross-equalization. The desirability for increased cross-equalization of the load on all cars is obvious in the interest of safety.

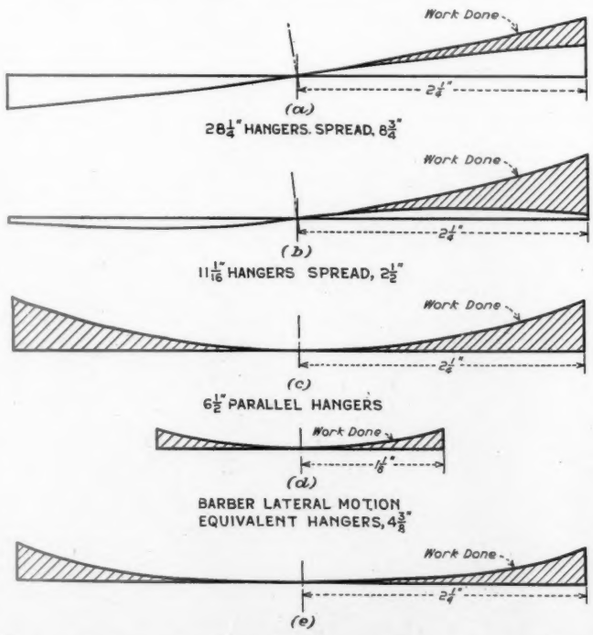
When the load is so cross-equalized, there must be an auxiliary support at least 25 in. from the center in order to prevent any possibility of the car body rolling off the truck from centrifugal force when the car hits a curve at high speed.

Some truck designers have thought that equalization in line with the rail is desirable on four-wheel trucks. Careful research has demonstrated that, while this equalization does no harm, it performs no desirable operating function.

A Derailing Condition

A derailing condition results from warp in the track between truck centers and not from the warp between wheel centers on one truck. By "warp" is meant the amount that one point on the rails is out of the plane of the three other rectangular points on the rails. The flexibility of the A. R. A. standard truck is always sufficient to permit one truck wheel to go down into a maximum-depth low joint without losing its share of the load on this side of the truck.

Swiveling Resistance—There is no swiveling resistance between the trucks and the car body except on approach curves with changing radius. The following table gives the results of tests to determine the maximum swiveling resistance under various truck conditions, with the track warped to put excessive loads on one side bearing. It shows the pressure required at the wheel flange to swivel one A. R. A. standard truck of a fully loaded 55-ton box car with the weight concentrated on one side bearing.



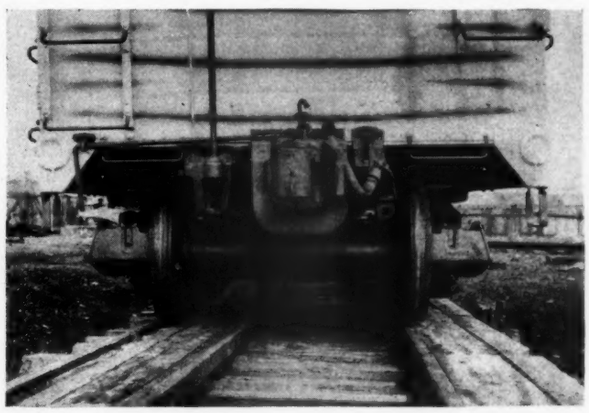
Ideal lateral motion for freight cars—Lift curves produced with equivalent compound hangers—15 in. for 1¼ in. each side of center and 4¼ in. final.

(a)—With the longest angular hangers in general service.
(b)—With the shortest angular hangers in general service
(c)—With the shortest equivalent parallel hangers in general service.
(d)—With the Barber lateral motion.
(e)—An ideal lift curve that has no compromise.

	Pressure, lb.
With friction side bearing	20,870
With roller side bearing	5,820
With T. H. Symington bolster	270

It is realized that this excessively warped track is found only occasionally in industrial yards, but the identical swiveling resistance is often encountered on main-line approach curves when the car body has rolled over to one side bearing.

Derailments—Most freight-car derailments occur when entering or leaving curves because, at these points on the line, the curve radius is changing and we have the combination of high flange pressure against the outside rail and minimum weight on the derailing wheel. On entering a curve, it is the rear truck that derails, and on leaving a curve, it is the leading truck that derails. The total flange pressure on approach curves is made up from the following three factors: The pressure necessary to slide three truck wheels, to swivel the truck, and the lateral component of car-body roll.



A.R.A. standard bolster on 55-ton rigid car, with 18-ton load —Roller-side bearings have ⅜-in. clearance—A.R.A. truck springs.

The outside rail on this 10-deg. curve is depressed to produce a track warp of 2 3/16 in. between truck centers when about 15 per cent of the normal load is on the outside leading-truck wheel.

When the car body rolls toward the outside rail, there is a maximum flange pressure because all three factors of pressure are involved. This pressure may spread the track, break the wheel flange or shear off the journal-box-brass lugs, but never causes a derailment because, with standard cars, 85 per cent of the body weight is then on this side of the truck.

When the car body rolls toward the inside rail, only the first two factors of pressure are involved, but the outside wheel will sometimes derail because then only 15 per cent of the body weight is on this side.

The following table gives the results of tests to determine the derailing tendency on approach 10-deg. curves with different trucks on warped track representing a soft spot at the outside rail, when the load (rigid 55-ton box car with 18-ton load) was on the side bearing adjacent to the inner rail. Here, also, only the first two factors of pressure are involved.

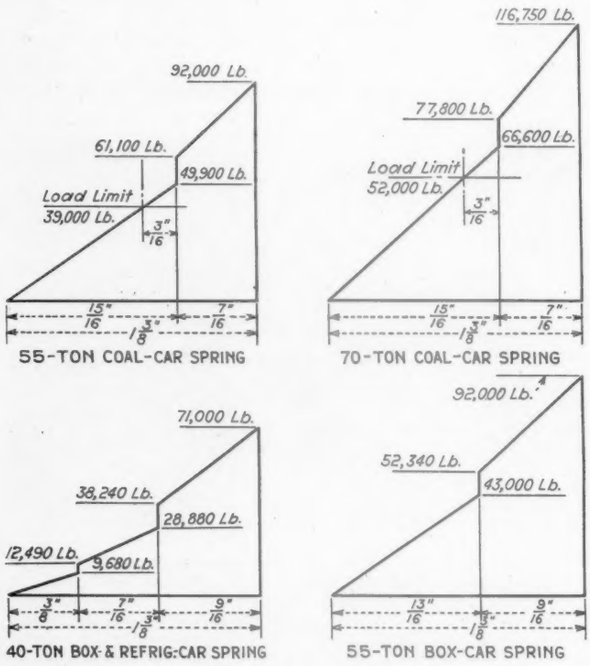
	Side-bearing clearance, in.	
	0	1/6
	Track warp, in.	
A. R. A. standard truck with A. R. A. standard bolster	1⁹/₁₆	2³/₁₆
A. R. A. standard truck with T. H. Symington bolster[1]	6	

[1] With this bolster there is no side-bearings clearance, and the truck will not derail until the body bolster comes in contact with the side frame.

Self-squaring—It is obvious that, on tangents, mini-

mum train resistance and flange wear result when the trucks are square and the flanges do not drag on the rails. Any design that will square a four-wheel truck after coming out of a curve and keep it square is worth considering.

Any truck that will prevent the wheel flanges from exerting high pressure, first against one rail and then against the other, is worth considering, because both

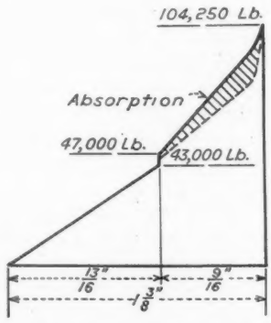


Non-harmonic spring curves.

train resistance and flange wear are involved. This surging results from either car roll or car nosing. If side-bearing clearance is large, cars are apt to roll excessively. If too small, cars with standard trucks will nose.

Car roll and nosing—If the synchronous impulses from the rail joints are not sufficient to cause objectionable, car roll, the truck will see-saw on its center plate, when there is sufficient side-bearing clearance, and not disturb seriously the mass of the car body.

If side-bearing clearance is a minimum or at zero, these vertical rail-joint impulses directly affect the car body mass with resulting nosing. This nosing originates from the car body. If side-bearing clearance is lacking, the truck cannot rock independently of the car body, and synchronous impulses from the rail joints will alternately compress the truck springs on opposite sides of the car. The lateral component of this action causes the car body to swing first to one side and then the other. This action occurs on all passenger cars. Without an easy lateral float of the car body on the trucks, the lateral movement of the car body will cause the trucks to surge first against one rail and then against the other and result in rapid end wear on brasses and journals. This nosing has the same period as car roll, and can therefore be identified with the synchronous timing of the rail joints at certain definite train speeds, often about 17 m.p.h.



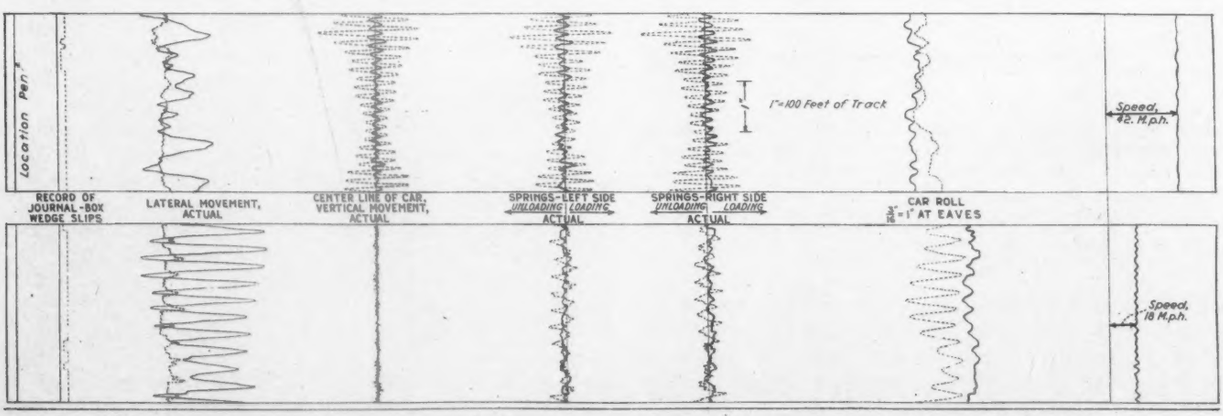
Spring curve of 55-ton box-car spring with one snubbed Edgewater unit.

Car roll can be reduced by reducing side-bearing clearance and by increasing the stiffness of the truck springs. Car nosing can be eliminated by increasing the side-bearing clearance or, with minimum side-bearing clearance, by providing a soft, easy lateral motion.

Either construction will break up any objectionable synchronous nosing action of the car body and truck in tune with the rail joints.

Safety—We have taken adequate care to prevent accidents resulting from the trucks by providing ample strength in the side frames and bolsters and in providing safety supports for the brake beams. We have done nothing to the trucks to eliminate derailments and to solve the broken-wheel-flange problem. An analysis of these problems indicates the need for better cross-equalization to prevent derailments and an adequate lateral motion on all freight-car trucks to minimize lateral shocks.

Guard-rail shocks—Car roll, or car nosing, will often take up all lateral clearances between the car body and the collar of one journal. If, at this instant, the opposite wheel flange strikes a guard rail at speed, something must yield in the line of force from the blow at the guard rail to the body mass, namely: The guard rail, wheel flange, journal collar, stop lugs on the brass, the side frame, bolster or the car body.


Location Pen
1"=100 Feet of Track
Speed, 42 M.p.h.
RECORD OF JOURNAL-BOX WEDGE SLIPS
LATERAL MOVEMENT, ACTUAL
CENTER LINE OF CAR, VERTICAL MOVEMENT, ACTUAL
SPRINGS-LEFT SIDE UNLOADING LOADING ACTUAL
SPRINGS-RIGHT SIDE UNLOADING LOADING ACTUAL
CAR ROLL 3/4"=1" AT EAVES
Speed, 18 M.p.h.

Specimens of research-car record with 40-ton springs in each car—spring-nest load of 17,350 lb.

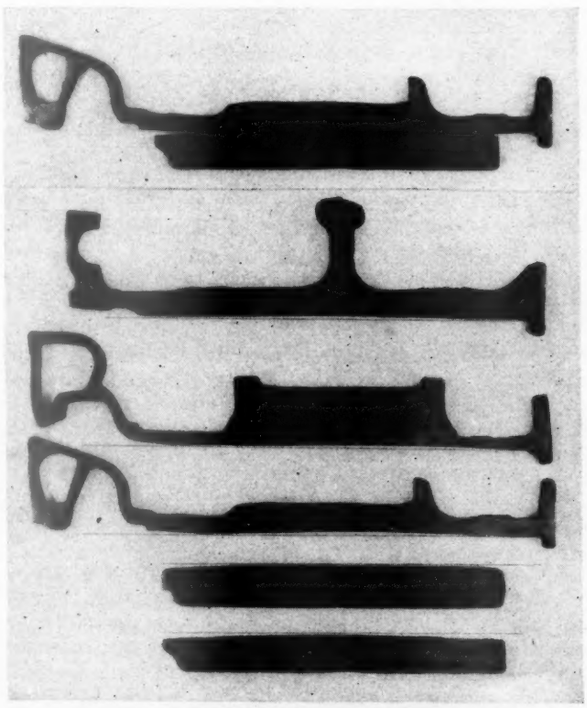
Full Lines: Car No. 1 with non-harmonic springs, full lateral motion (Curve *e*, of chart showing lift curves), and non-slip journal-box wedges. Broken Lines: Car No. 2 with A.R.A. springs, no lateral motion and standard journal-box wedges

If the blow is taken by the opposite journal shoulder, the force must pass through the top flange on the brass, and through the wedge to the roof stop lugs on the box on the same side of the truck as the offending guard rail.

This is nothing but a force of lateral acceleration. If we consider the weight on the rails of one truck of a fully loaded 55-ton car as 100, the body weight on one truck is 90 and the truck weight is 10. With adequate lateral motion, the mass to be laterally accelerated at one instant is the truck only, or 10, and the velocity of the lateral acceleration of one wheel is in direct proportion to the speed of the train and the entering angle of the guard rail. If we consider that, for a certain speed and guard rail, this lateral wheel velocity is 2, the lateral velocity of the center of gravity of the truck mass is 1. Then MV^2 for the truck = 10.

With a similar car, without lateral motion, we must add the force to laterally accelerate one-half of the car body with load. In this case the body mass equals 90 and the lateral velocity is 1, because, at any one instant, this lateral velocity of one-half of the car body is one-half of the lateral velocity of the wheel striking the guard rail. Then MV^2 for the car body equals 90 and the sum of the two equals 100.

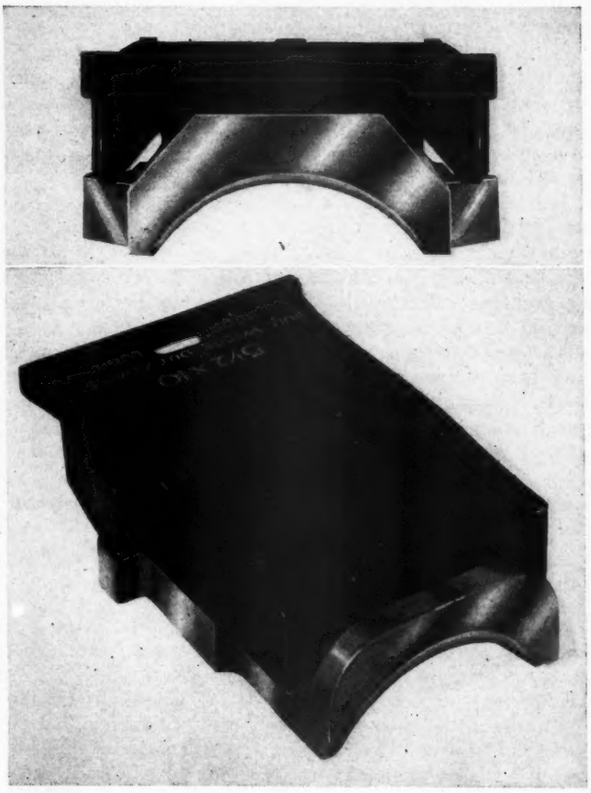
There are several factors of correction, namely, the lateral yield in the truck structure, the force needed to compress slightly the truck springs because of the small lifting angle of any lateral motion, and because the



Wear between top of journal-box wedge and roof of journal box.

lateral force on the car body is applied at the center plate some distance below the center of gravity of the car body. We are certain, however, that the force of lateral acceleration at the guard rail without lateral motion is many times this force when we have adequate lateral motion. The same advantages accrue from adequate lateral motion when the dynamic shock comes on the throat of the wheel flange.

If we can, with suitable lateral motion, greatly reduce



Construction of new wedge which is interchangeable with present standard wedge

this dynamic force, we automatically increase the factor of safety for the wheel flange many times and therefore largely eliminate broken wheel flanges.

If the wheel flange is strong enough to stand the shock, the brass is sometimes broken.

It would seem essential, therefore, that any lateral motion provide sufficient travel and gravity resistance so that there is *always* an ample reserve of yield to insure the minimum shock to the wheel flange.

It is fortunately a rather rare coincidence when a wheel flange strikes a guard rail at speed at the instant when all lateral clearances are absorbed in the opposite direction.

There is no doubt about the fact that there are many lateral shocks that are not sufficient to break a wheel flange or shear off the brass lugs, but are sufficient to break down the oil film on the journal collar, or shoulder, with resulting rapid end wear on brasses and journals.

Lateral Motion

An adequate lateral motion must accomplish two separate important functions: The floating action at the center must be easy in order to prevent nosing when side bearing clearance is at a minimum, and there must be sufficient travel and gravity resistance to insure lateral yield under all operating conditions and to prevent the bolster from striking the side frame.

This subject can be studied best with the swing-hanger construction used on all passenger cars, which operate with little or no side-bearing clearance. These hangers vary in length from 28¼ in., spread 8¾ in. at the bottom, to the equivalent of 6½ in. parallel hangers.

No matter what design is used, it is always a com-

promise to give the best results to eliminate nosing and provide sufficient yield and resistance.

With angular hangers, the bottom spread must be small to eliminate nosing and increased to give sufficient lateral resistance. If parallel hangers are used, they must be long enough to eliminate nosing and short enough to provide sufficient resistance in the usual travel of 2¼ in.

It is a good practice on a straight railroad to provide best against nosing, and on a crooked railroad to consider lateral resistance as of first importance. Pullman cars that operate on all sorts of railroads probably offer the greatest difficulty in this compromise between nosing and needed resistance.

An ideal hanger for all passenger cars would seem to provide a compound lift curve to produce an easy float at the center and ample lift toward the end of the motion. Shown in one of the drawings are lift curves:

(*a*) With the longest angular hangers in general service
(*b*) With the shortest angular hangers in general service
(*c*) With the shortest equivalent parallel hangers in service today
(*d*) With the Barber lateral motion
(*e*) An ideal lift curve that has no compromise

Lift curve (*e*) can be produced either with compound swing hangers or with compression rockers.

It has been demonstrated that 6½-in. parallel hangers will induce little nosing on passenger cars with no side-bearing clearance. The reason is that combined helical and elliptic springs have a very flat load curve, and therefore largely absorb the effect of track irregularities without disturbing the car body.

On freight cars, with only helical springs, track irregularities are more readily conveyed to the car body, and an easier lateral motion at the center than on passenger cars is required to prevent the car-body swing from carrying the trucks with it. Curve (*e*) has therefore been found best for freight cars.

One objection to all swing hangers is that the lateral motion is continuous and the millions of movements necessitate a periodical renewal of pins and bushings in the hangers on account of wear.

With properly designed rockers, there is no sliding friction and the parts will last, with no deterioration, for the life of the car. When rockers, or rollers, are used for lateral motion, experience has shown that the car should be equally stable with the weight evenly distributed on the bolster, or concentrated on one rocker, which often occurs with rigid-body cars. This means that one rocker should give equal lift each way from central position. It is also important that the rocker-wear factor, viz., the product of its radius by its length, be sufficient to insure long life with ordinary steel rocker bearings.

Four-point Suspension—There has been much discussion about three-point and four-point suspensions. When cars are supported on four rockers, there is an even four-point support only on level track with rigid-body cars. Often the rigid-body car is supported on three rockers, and, on unusual track, the main supports may be two diagonal rockers instead of two diagonal side bearings, as on standard cars.

Many attempts have been made in the past to carry a freight car on four-rocker side bearings in order to minimize swiveling friction and reduce weight. The only well-known cars of this construction in service are 500 100-ton coal cars on the Norfolk & Western. They were designed for great flexibility, as a rigid-body car of this construction would not stay on the rails because there is no cross-equalization of the load.

With rigid-body cars, the rocker supports must be sufficiently close together to provide the essential cross-equalization of weight necessary always to maintain 30 per cent of the weight on the light-loaded wheel and thereby prevent derailments. If the rockers are not of conical form, provision also must be made to take care of the angular movement between the truck and body bolsters, or the mechanism will lock and derail the truck on a curve.

The only reason for increased swiveling resistance with roller side bearings when the weight is largely on one side bearing, is that the rollers are not of conical form, and therefore must slide a little on their bearings because of the angular movement between the bolsters.

When four rockers are used to support a car body, it would certainly seem desirable to arrange for gravity to square the truck when coming out of a curve. It is believed that this failure of the truck to square itself is responsible for increased train resistance and wheel-flange wear.

Barber Lateral Motion—The only lateral motion in general service on freight cars in this country is the well-known Barber lateral motion. This motion is the equivalent of parallel hangers 4⅜ in. long. With such short hangers, cars will nose if there is little or no side-bearing clearance. The travel of 1⅛ in., with a lift of 3/16 in., may not provide sufficient travel and resistance always to insure lateral yield. The makers of this device advise that, if desired, they can increase the travel and lift, which would give better action to prevent nosing and to provide needed travel and resistance to avoid lateral shocks.

The Truck Springs

With the large masses and high speeds of modern freight cars, the cumulative harmonic vibration of helical truck springs is responsible for a number of our operating problems.

Because of the small available space, freight-car truck springs are made in helical or coiled form, and also because the same springs must be suitable for empty or fully loaded cars and there must be no excessive variation in coupler height.

Harmonic Spring Oscillation—All helical springs have definite periods of vibration dependent upon the springs themselves, the mass supported by them and the speed. This vibration, without pendulum action of the car body, is in tune with the intermittent forces from the rail joints in the track at speeds of from 35 to 60 m.p.hr.

The resulting cumulative spring oscillation is probably the largest factor in damage to perishable freight and to truck springs. This oscillation is also a large factor in velocity train resistance and, in the author's opinion, for the initiation of transverse rail fissures when the springs go solid.

We have frequently recorded spring oscillation that closes solid A. R. A. spring groups of 40 and 55 tons capacity at the rate of three to four times per second.

All cars are subject to spring oscillation at certain particular speeds. We often identify one type of car as jumping when other cars are not jumping. This is because the critical speed for the other cars was not attained during the time of our observation.

Few railroad men realize that the shock inside a freight car from spring oscillation may cause a man to crash through an ordinary chair to the floor of the car. When once experienced, one can easily understand why

so much beef is found on the floors of refrigerator cars; why fat cattle lose from 10 to 15 per cent in weight in a long shipment to the stockyards; why certain fruits must be picked so green, in order to stand shipment, that they never reach perfection at a distant market; why we have so many spring failures on cars loaded to the rail limit; why such loaded cars do so much damage to rails. The breaking up of harmonic truck-spring action will automatically solve all of the above problems.

The first moves to stop the failures of truck springs under harmonic action were to increase the static capacity of the coils and then to add more A.R.A. standard coils and increase the static capacity of the spring group. Both actions materially helped to diminish spring failures, but had no effect in reducing harmonic spring action, except to increase the critical speed for this action. All such heavier-capacity groups will go solid under harmonic action when the track, the lading, and the train speeds are favorable to such action.

Concentrated effort is now being made by many railroads to break up this harmonic truck-spring action by the use of various means to introduce friction in the spring action so that the compression curve of the spring will vary materially from the release curve.

Excessive harmonic truck-spring action can be prevented by constructing spring nests that have irregular compression curves as illustrated in the chart showing the non-harmonic spring curves. The best general performance of springs was had with a spring group having the curve represented in the small chart showing the spring curve for one snubber unit. In this spring group, an Edgewater ring spring was under sufficient initial compression so that it was inoperative except under harmonic spring action. It is evident that any harmonic action tends to be broken up both by the sudden change of direction in the combined spring curve and by work absorption.

A great advantage in this spring-group construction is that the friction elements are only working in an emergency, and can therefore be relied upon for a long life. It is believed that a snubbed Frost spring in the same group would give approximately the same results.

The first essential for any truck spring would seem to be to prevent its ever going solid under vertical oscillation. The fiber stress then, at some point in a coil, might easily go to 250,000 lb. per sq. in., when there would be a certain failure. If one coil in a nest is broken, the spring group will thereafter go solid much more readily, with resulting destructive shocks to lading and to the rails.

It is believed by many engineers that excessive harmonic spring oscillations at critical train speeds may be caused by eccentricity of the wheels. Tests will be made to determine what, if any, reduction in harmonic spring oscillation can be effected with wheel treads ground concentric with the journals.

[Here the author gave a description of the methods for measuring the force of vertical acceleration and the various instruments installed in the two research cars. —Editor.]

The Journal-Box Wedge

A number of railroads are having difficulty with the wear between the top of the journal-box wedge and the roof of the journal box. If the wedge is harder than the box, the wear occurs in the roof of the box. If the box is harder than the wedge, the 78-in. radius on top of the wedge is worn flat. One of the illustrations shows a photograph of actual conditions as they exist. This is a serious matter, because, with loss of proper equalization on top of the wedge, there may result an excessive load at the front or back end of the journal that will cause a hot box.

Journal bearings often wear tapered, and if this tapered wear is coincident with loss of equalization on the wedge, a new brass will certainly have a concentrated load near the shoulder or the collar of that journal. A study has established the fact that all of this wear, resulting in loss of equalization, is caused by the wedge's sliding on the roof of the box at right angles to the journal.

It has been demonstrated that all journal brasses are normally against the outer center lugs in the journal boxes because they are pushed there by the brakes. It has also been demonstrated that there is a frequent movement of the journal and brass in the journal box, often to the extent of the clearance between the brass and the center stop lugs in the journal box. This play is always in excess of the lateral play between the beveled faces of the brass and the beveled faces of the wedge.

By increasing the play between these beveled surfaces, it has been found that wedge slippage in the box is entirely eliminated and the radius on top of the wedge can be reduced from 78 in. to 24 in., thereby providing better equalization of the load on the center of the journal, with no loss of this equalization due to wear. An illustration shows the construction of this new wedge, which is interchangeable with the present standard wedge. The wedge is hardened and is provided with three small beveled lugs that gradually bed themselves into the roof of the journal box.

One blow from the journal shoulder drives this wedge against the front roof-stop lugs in the journal box, and thereafter it never shifts in the box. There is ample bearing surface to permit, without wear, transverse sliding and sliding in line with the journal between the flat bottom of the wedge and the flat top of the brass. It will be noted that provision is made to prevent any possibility of the standard brass upsetting in the journal box should there be a seizure between the brass and the journal.

Spring Planks

A study of the action of the A.R.A. spring plank on standard trucks has led to the theoretical conclusion that it performs no important function. The function of the spring plank is to hold the truck square; that is, to keep one side of the truck from getting ahead of the other. An exhaustive investigation of the actual fits of the four bosses of the A.R.A. side frame in the four holes in the spring plank has shown the manufacturing necessity for sloppy fits, which permit an initial large angular movement between the side frame and the spring plank. It is believed that if the bearings between the side frames and bolster are sufficiently long and close fitting, the bolster can be utilized to maintain essential squareness of the truck. The spring plank can then be dispensed with entirely and the truck weight thereby reduced about 600 lb. on each 70-ton car. When the spring plank is eliminated, it is a simple matter to arrange the truck so that the cost of changing wheels is largely reduced.

It is not considered sound from a purely engineering angle to tie the side frames together at the bottom to a fixed dimension when the tops of the side frames are not similarly controlled.

The bolster applies all lateral forces to the side frames, and, without a spring plank, we are certain that the reaction points are at the tops of the journals. Secondary lateral stresses in the side frames are thereby

minimized. Service tests are in progress to demonstrate the efficiency of this type of truck construction.

Side Frames and Bolsters

Cast-steel side frames and bolsters have been vastly improved in design in the past few years. Further improvement can be made. The ideal ultimate standards will have essential strength, minimum weight, and maximum wearing surfaces to insure long service life.

This will be accomplished by designs that minimize secondary stresses and prevent a concentration of such stresses at any points in the structure. Metal that is never adequately working also should be eliminated. It is believed that future specifications for these parts will be based largely on elastic limits.

There are today a large number of designs in current use that are not interchangeable and require a multitude of patterns and coreboxes. Brake-hanger brackets are also of various designs and degrees of efficiency and ultimately will be standardized. Manufacturing tolerances permit quite a difference in the lengths of side frames, and the practice will soon become general of mating side frames in the same truck as now holds in mating wheels on the same axle. As the normal position of each brass is against the outer center stop lugs in the box, it would seem proper to mate side frames on the basis of the distance between the faces of the outer center stop lugs and not from center to center of journal boxes.

Additional Research

When the writing of this paper was undertaken, it was believed that this entire research could be completed in time to tabulate all the results. Unforeseen delays have made this impossible.

It is considered premature to comment on truck-spring performance at this time. We first must get the record of performance of all types of truck springs at all speeds up to 60 m. p. h., and with various ladings. No tests have yet been made to measure the magnitude and frequency of lateral forces or of the effect of vertical spring oscillation on perishable freight.

An exhaustive program for joint freight-car-truck research has, been arranged between several of the larger manufacturers of trucks and springs and one of our important railroads. The results of this work cannot be included in this paper, but will, at a later date, be made public.

Discussion

F. H. Clark, consulting engineer, New York, in discussing Mr. Symington's paper, pointed out that the author's proposal was apparently to eliminate the center plate, and that the car body would be carried on rockers placed between the body and truck bolsters. He agreed that the spring-plank connection to the side frame could be dispensed with, and approved of the author's suggestion that side frames should be mated for length.

F. J. Herter, assistant engineer of car construction, Chesapeake & Ohio, Richmond, Va., agreed with Mr. Symington that derailment of freight cars, damage to car parts, and swiveling resistance which affects train resistance, deserve considerable research study. He pointed out that the bolster design proposed by the author eliminated side-bearing clearance, the existence of which frequently caused the car body to attain a large initial lateral velocity to produce car roll. The function of the rocker, he said, to provide lateral motion is effective in reducing high stresses due to shock resulting from flange impact with rails, including guard rails. He questioned whether or not the car body would overturn on the rocker in the event something should lodge on the rocker seat and restrict the rocker motion. This would, in effect, be the same as placing a rigid side bearing much nearer the center of the car.

Mr. Herter and a number of other speakers stressed the necessity of overcoming excessive spring oscillation. Experiments with a spring dynamometer to determine the vertical acceleration due to end shock, showed this to be more serious with respect to lading than spring oscillation. Mr. Herter said that the results indicate that the vertical acceleration must be due to the fact that the center of draft is below the center of gravity of the center-sill section. This was on the assumption that the test cars are of A.R.A. underframe construction, in which case there is an eccentricity of one inch or more. Similar studies with a fish-belly center sill to which the upward deflection would be at a minimum would be interesting. Mr. Herter questioned the advisability of decreasing the radius of the back of the wedge from 78 in. to 24 in., unless it was found that the force is not sufficiently concentrated to crush the material in the roof of the box.

Alan N. Lukens, mechanical engineer, Railway Steel Spring Company, New York, and member of A. S. M. E. Special Research Committee on Springs and also the Committee on Springs, American Society for Testing Materials, said that most of the springs in use, including the A.R.A. standard springs, were designed many years before scientific research had shown that the stresses were far higher than anticipated. The A.R.A. springs designed for a stress of 80,000 lb. per square inch solid, actually develop 93,000 lb. at that point. In addition, he said, while the stress developed by the rated load is not far from reasonable, the practice of loading cars to axle capacity regardless of the springs, subject the spring to stresses far beyond the reasonable limit.

In discussing the vertical harmonic vibration of springs, Mr. Lukens pointed out that elliptical springs generate considerable friction between the leaves during movement. This friction, if properly utilized, prevents the starting of harmonic vibration, which fact has led to many attempts to add some friction on to helical springs which may also prevent vibration. He commended Mr. Symington's suggestion to use spring snubbers, and said that the results of the research showed a distinct improvement over the present standard springs. Mr. Lukens suggested that space should be provided for groups of springs 12 in. wide instead of the present standard of 11 in. together with an additional inch or more in length.

Jos. K. Wood, consulting engineer, New York, suggested the use of springs of variable pitch which would tend to dampen vibration.

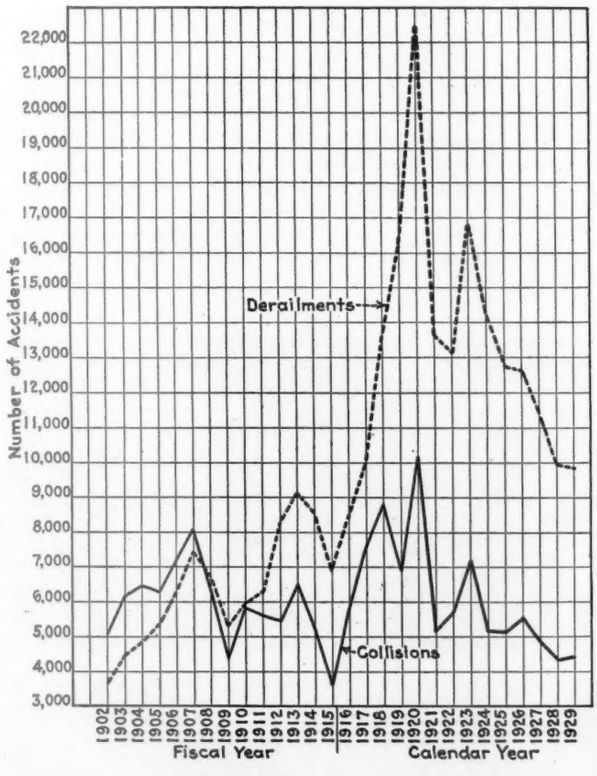
L. K. Sillcox, vice-president, New York Air Brake Company, suggested that a longer distance between truck centers as compared to the distance between wheel centers would obviate unequal weight distribution that tends to cause derailments due to track warps. He also brought up the point that the vibration of truck springs at critical speeds sometimes coincide with bridge vibration.

George G. Floyd, mechanical assistant to the president, American Steel Foundries, defended the four-wheel truck and pointed out that often derailments were charged to the design of the truck when the fault

actually lay with the handling of the train by the locomotive engineman. Improper handling of the air brakes, he said, tended to cause derailments.

W. E. Symons, consulting engineer, New York, referred to an investigation of car derailments which he made a number of years ago for a western road. The rigidity of the car structure, truck connections to the body and the design of the trucks themselves frequently caused the wheels, under certain conditions, to rise from the rail considerably above the depth of the flange. He also found that cars which rolled heavily at a certain speed would cease rolling at a higher and lower rate of speed. The length of wheel base, speed and track conditions, he said, were the governing factors, while side-bearing location and clearance were considered.

W. P. Borland, director, Bureau of Safety, Interstate Commerce Commission, stressed the need for improvements in the present design of car trucks from the standpoint of safety. Derailments, he said, were the most prolific sources of accidents. He compared the accident records for the periods from 1902 to 1911 inclusive, and for 1920 to 1929 inclusive. During the first period, he said, there were 61,329 collisions and 56,136 derailments; during the second period there were 57,382 collisions and 136,758 derailments, a decrease of 3,947 collisions and an increase of 80,622 derailments. The property damage from collisions for the first period, he said, was $48,235,952 and for the second period $57,450,943, an increase of less than $10,000,000; from derailments, $48,965,656 for the first period and $159,635,736 for the second period, an increase of more than $110,000,000. It should be borne in mind, Mr. Borland said, that these amounts refer only to damage to railway property and do not include amounts paid for lost or damaged lading, personal injuries or other claims growing out of such accidents.



Comparison of number of accidents caused by derailments and collisions

In a further examination of the accident record for the year 1929, Mr. Borland stated that of the total of 9,871 derailments reported, 4,510 were due to defects in or failures of equipment, while only 2,080 were due to defects in or improper maintenance of way and structures. There were 6,643 train accidents due to defects in or failures of equipment, of which 1,342 were attributed to trucks and 1,867 to wheels and axles. (Tables 63 and 65, Bureau of Safety Accident Bulletin No. 98.).

In considering all of these statistics, he said, the fact should be borne in mind that they include only those accidents which resulted in death, personal injury or property damage amounting to $150 or more. It is a matter of common knowledge that there are a large number of similar accidents not sufficiently disastrous to be included in these statistics but which are a constant source of delay and expense to the railroads and of trouble and worry on the part of railroad operating officers.

Research work of the character conducted by Mr. Symington, Mr. Borland stated, is therefore directed along lines which should be productive of important results. It is of direct interest to the Bureau of Safety, Interstate Commerce Commission, and should certainly enlist the active support of railroad officers who are responsible for the design, construction and maintenance of cars and for safe, efficient and economical operation of the railroads.

* * *

TO EVERYWHERE IN CANADA
A GREAT RAILWAY
first
IN ENTERPRISE
FIRST - IN SIZE
STRONG words—but true! "First in size," because Canadian National is the largest railway system in America, with over 23,000 miles of track, over 108,000 employees, a chain of magnificent hotels, steamships on two oceans, vacation resorts, hunting and fishing camps, a telegraph system, radio stations, an express service.
"First in enterprise"—because Canadian National is alive with the urge to new achievement. It has led the way in new luxury and new efficiency of equipment—first with individual radio reception on its trains first to accomplish telephone connection from a moving train—first in oil-electric locomotion—first in Canada with single room sleeping cars.
When better equipment is found, the old is replaced. Not very long ago Canadian National scrapped seven solid miles of locomotives to make room for better ones. Another time it put a whole town on flat cars and built it again twenty miles away to make a better junction point. Canadian National is never finished—because it is always growing.
Canadian National is your open door and your guide to Canada. Its offices in important American cities are ready to supply complete information. Its services take you direct from American centres to everywhere in Canada.
CANADIAN NATIONAL
THE LARGEST RAILWAY SYSTEM IN AMERICA

One of a series of advertising posters used by the Canadian National

Wheeling A Switcher In 37 Minutes

Shop facilities and the organization of a spot system has enabled the B. & O. to speed up locomotive repair work, reducing time in shop to a minimum

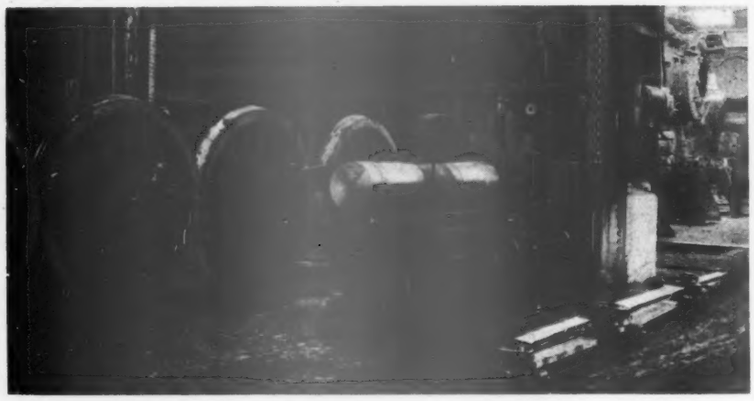


Fig. 1—The wheels and the rods on the machine shop floor

THE first glance at the title of this article may cause some readers to conclude that "here is another set-up job performed solely for the purpose of making a record that cannot be duplicated in every-day work." The title may be misleading, not in its presentation of a fact, but in the possibility that the reader may feel that the object of the article is to record an outstanding performance in wheeling a locomotive—such is not the case. Actually placing the driving wheels under an eight-wheeled switcher, ready to lift the engine over to another track, in 37 minutes is not in itself unusual but, the fact that the men and facilities in the Glenwood, Pa., shops of the Baltimore & Ohio have been so organized and supervised that 37-minute wheeling on such a locomotive is a week-in and week-out accomplishment, is unusual.

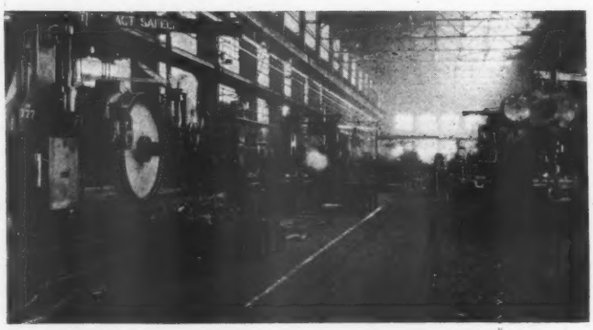
Wheeling a locomotive is but a small part of the job —in the case used as an example in this article requiring but 37 minutes out of a total of 1440 minutes that the engine was actually under repair in the shop—but the entire job has been so organized that the time spent in the shop by locomotives on the B. & O. has been reduced to a minimum. The spot system of locomotive repairs has been the means of accomplishment and the result is an output of two classified and one heavy running repair jobs for each working day.

The Spot System

For more than two years the Glenwood shops of the Baltimore & Ohio have been operating under the spot system. This system is particularly adapted to a longitudinal shop such as the Glenwood shop is. The idea was originally developed at the Mt. Clare (Baltimore) shops and has gradually been extended to other longitudinal shops on the B. & O. system. At both Mt. Clare and Glenwood the system is designed to produce an output of three classified repair locomotives each working day. In order to accomplish this, it has been necessary to take all of the visible lost motion out of shop operation and this has been done by attention to the little things that take time and interfere with the maximum daily output of individual workmen.

The spot system involved the separation of the shop relating directly to locomotive repairs into four general subdivisions: (1) A section where the stripping operations are performed on incoming locomotives and the finishing operations performed on outgoing locomotives; (2) a section for heavy classified repairs; (3) a section for light repairs; (4) a section of the shop known as the balance section. Into this section are placed locomotives involving heavy accident or rebuilding repairs.

Because locomotives going through a shop for classi-



Above—Fig. 2—Broad aisles and strategically located machinery simplify the job of transporting material and parts

Below—Fig. 3—At 3:35 p.m. this was the condition of the wheeling pit

Fig. 4—The four sets of drivers have been placed on the pit

fied repairs require such a wide variation of operations as between the lightest repairs and the heaviest repairs, it is necessary, in the operation of the spot system, to provide a balancing section in which to take care of those locomotives requiring unusual operations. These locomotives remain in the balancing section of the shop until the work on them has been brought to a stage where they may take their place in the regular line of locomotives passing through the shop toward completion.

After a locomotive is brought to the shop, it passes first through the stripping section from which it either goes to the balancing section if the work is of an unusual nature or else it is placed in either the heavy repair or the light repair section, depending on the nature of the repairs.

Glenwood is a dead-end shop and the erecting shop occupies an area of 90 ft. by 440 ft. in the center of the shop. Locomotives passing through the shop for classified repairs work their way down one of the outside tracks and back out of the shop on the opposite track. The center track is used for wheeling, unwheeling and, at one end for the locomotives occupying the balancing section. The preliminary stripping, sand-blasting of parts and inbound mechanical inspection is performed before the locomotive is placed on the erecting shop track so that when it actually enters the shop it is ready for the final stripping and unwheeling and ready to take its place in the progressive line.

The progress of the work covers 13 different "spots" at which different detail operations are performed and the locomotives in the shop are actually moved from spot to spot as the work progresses. The moving of the locomotives is taken care of by the second shift so that there is no interference with the actual productive work of the day-trick men. All wheeling and unwheeling is done on the second trick.

The heaviest repair jobs cover practically the entire length of the erecting shop on their way over the different spots while the lighter jobs may only move half-way into the shop then cross over and start back.

A Typical Example

In observing the functioning of the spot system at Glenwood, it was decided to follow the progress of repairs on Engine No. 637 which was taken into the shop

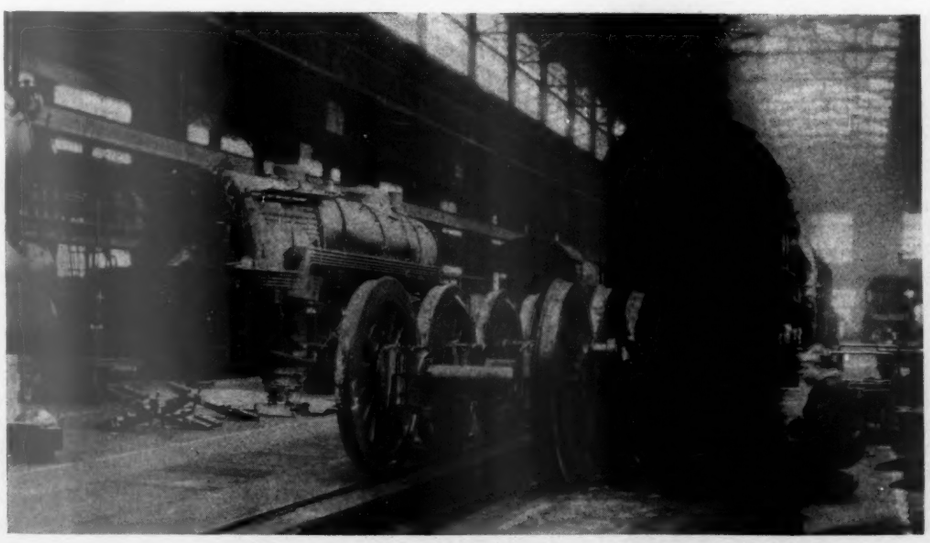


Fig. 5—The wheels have been trammed for location and the rods have been placed on the pins

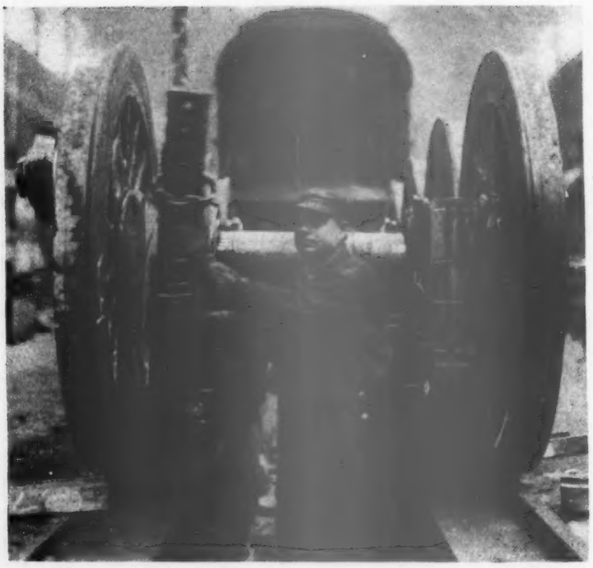


Fig. 6—The pedestal binders are placed on blocks under the driving boxes to facilitate handling

Fig. 7—Lifting the engine over to the wheeling pit

at 7 a. m., on a Tuesday to be given Class 5 repairs. The work reports showed only the work requested by the operating department when the locomotive was sent to the shop. In addition, the shop inspector at Glenwood found several other items of work that needed to be taken care of as the engine was going through the shop in order to put it in condition to run out the mileage in service demanded after the making of Class 5 repairs. One such major item of work performed but not reported on the original report was the renewal of the front bulkhead of the tank cistern.

Engine No. 637 occupied a position along with two other locomotives in Spot No. 1 of Section I of the shop on the Tuesday that it was taken into the shop. By 3:30 p. m. of that day the stripping operations had proceeded to such an extent that the engine was unwheeled by the second trick men and the major parts requiring repair or renewal were distributed to the different machine or repair groups throughout the shop ready to be worked on the following morning. The wheels were taken to the wheel gang where all new tires were applied, the journals trued up, the main crank pins trued up and the eccentric cranks re-applied. The driving boxes were sent to the box gang where new crown brasses were applied and bored; new hub liners applied and faced; new grooved steel shoe and wedge liners were welded in place and planed and a new special type of journal bearing lubricator using oil instead of grease was fitted to each box. The rods were sent to the rod gang where new brasses and bushings were applied and finished; the spring rigging was sent to the spring gang where new pins and bushings were applied and similar repairs were made to the brake rigging by the brake gang. The shoes and wedges were renewed where necessary and planed; the binders were sent to the blacksmith shop for closing in and, upon reapplication, several new binder bolts had to be made and applied.

The boiler work reported to the shop and included in the repairs consisted of rewelding 20 leaking flues, renewing four arch pipes, bobbing and cupping leaking staybolts and radials, renewing the front-end netting, washing the boiler, testing the boiler, patching a leak on the left side of the tank and repairing a leak in the back of the tank.

While the above work was being taken care of the locomotive was progressing through Spots No. 7, 8 and 9 of Section III of the shop (the light repair section) to Spot 10 where, at 3:30 p. m. on Thursday it was ready for wheeling. This brings this article up to the point where the wheeling operation is about to be used as an example of the manner in which the shop functions on a difficult erecting operation so as to perform the job with the least effort.

An Erecting Shop Job

Advance preparation is an important part of any job and in this case the value is apparent. In the rearrangement of the shop for operation under the spot system the departmental groups and the machines and equipment therein have been located in such a manner as to eliminate so far as possible the handling of material or parts by manual labor. Even where cranes

are provided and power trucks are used, the arrangement has been such as to require the movement of parts over the shortest possible distance.

Some idea of the manner in which this has been worked out may be seen by the fact that the side rods and driving wheels in their movement from the rod and wheel gangs, respectively, to the wheeling location need move over a distance of not over 180 ft. The driving boxes, in moving from the driving-box gang to that point in the wheel gang where they are fitted to the journals, move only 48 ft. The grouping of machine tools and shop equipment in the machine shop at Glenwood has been worked out in such a manner that the different departmental groups are arranged with the idea of requiring the least handling of parts from locomotive to machine floor and from machine floor back to the erecting shop spot where the re-application of the material is made.

This brings us up to the point in our story where the actual wheeling operation is about to begin. In Fig. 1 may be seen the driving wheels and side rods for locomotive No. 637 as they appeared on the floor of the machine shop at 3:15 p. m. on Thursday afternoon. Fig. 2 is a general view taken from the same location, except in the opposite direction, showing the rod and axle department on the left foreground and the crank pin and rod storage location in the left foreground. It is along such aisle-ways that the finished material and parts move to the erecting floor.

As previously stated, the wheeling operation is performed on the second trick and in Fig. 3 may be seen the condition of the wheeling pit at 3:35 p. m. It is of interest to note that the wheeling pit has some special construction in that a shelf is built along the side of the pit next to the rail which, as may be seen later, is used for the blocks on which the pedestal binders are placed before the locomotive is let down on its wheels. There are two overhead cranes in the erecting bay, each of 100 tons capacity. One of these cranes may be seen on the runway while the other is in the background picking up the wheels from the machine bay.

In Fig. 4 we see a view at 3:42 p. m. By this time all of the driving wheels have been lifted over by the crane and placed on the wheeling pit. The pedestal binders may be seen on the floor to the right and to the left of the wheels. Another view, taken at 3:47 p. m. shows the wheels in position being trammed with the left side rods on and the right side rods just having been put on. The pedestal binders and the shoes and wedges may be seen on the floor. It might be well to mention here that the entire wheeling operation is performed by one machinist with one helper with the assistance of the two crane operators and a man who directs the movement of the cranes by signals from the floor. By 3:59 p. m. the blocks under each journal bearing, which are used to hold up the pedestal binders, have been placed on the shelf in the wheeling pit and the mechanic is seen placing the last of the binders on the blocks. Six minutes later, at 4:05 p. m. the binders are all up on the blocks, the shoes and wedges have been placed in position on the boxes, the rods are on and the locomotive is in the slings on the crane being lifted over from the adjacent truck to the wheeling location preparatory to being let down on

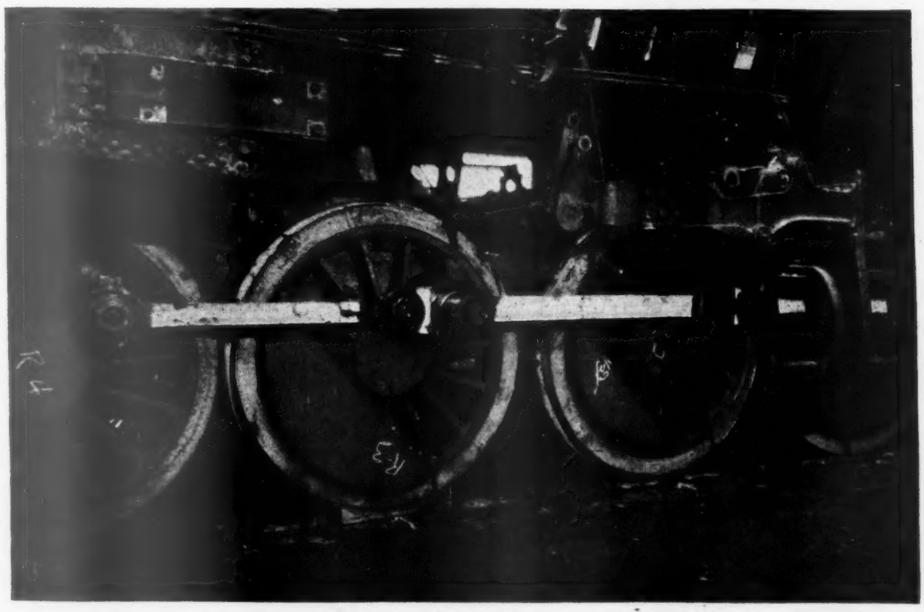


Fig. 8—At 4:08 p.m. the locomotive is down on the boxes and the binders are being set up

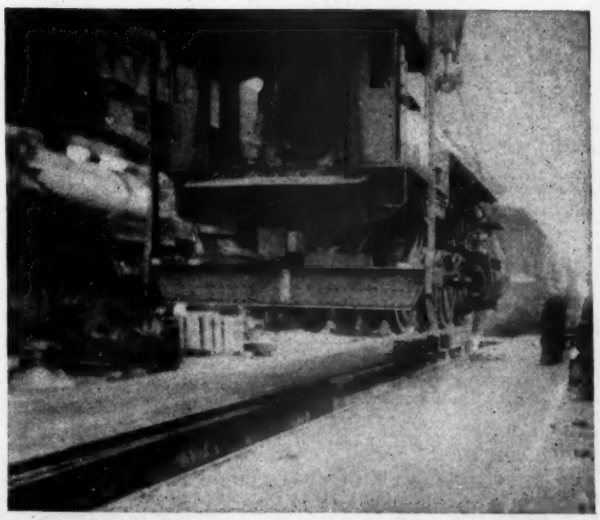
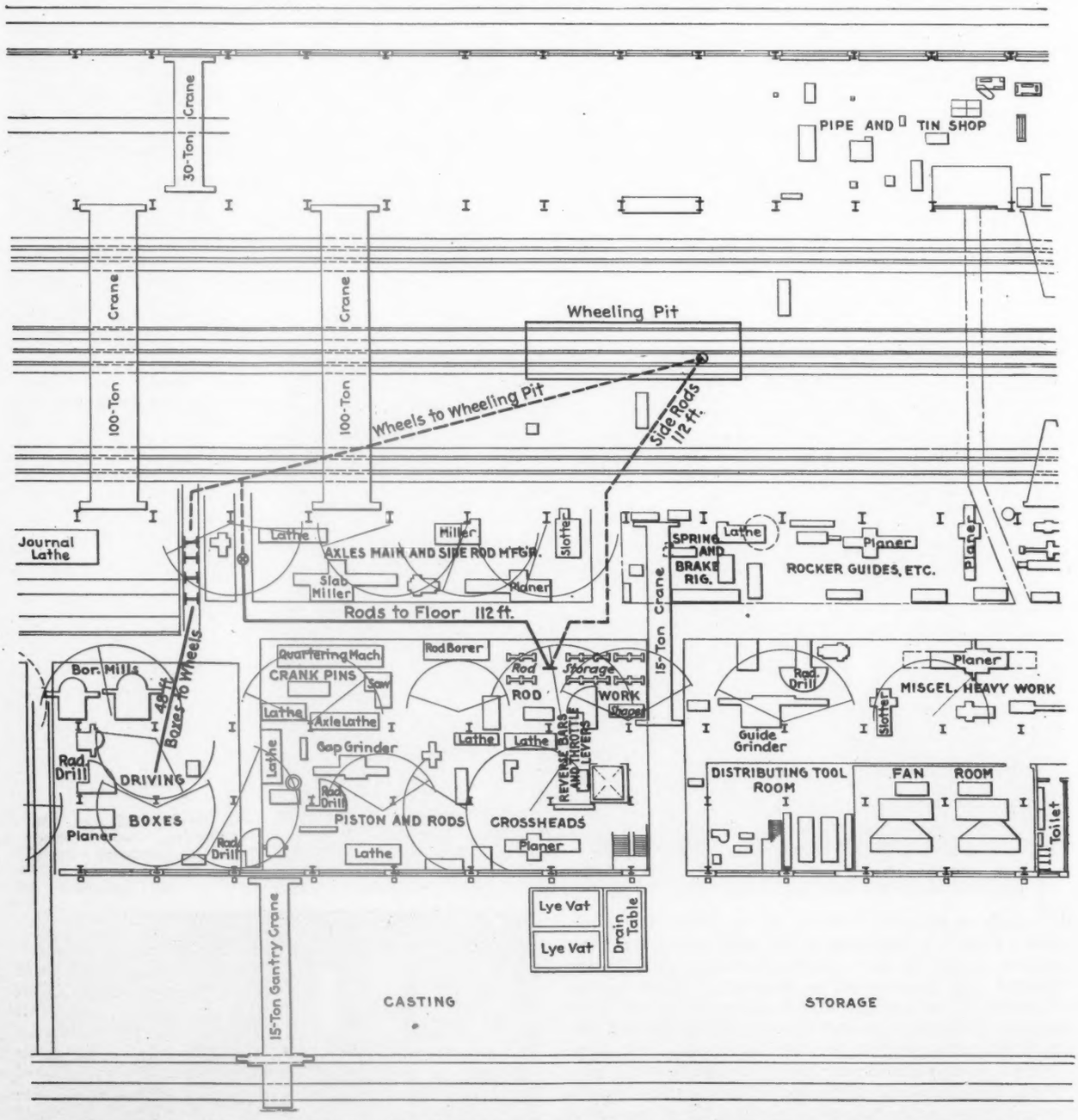


Fig. 9—At 4:12 p.m. the locomotive was lifted over to another track

the wheels. This is shown in Fig. 7. Fig. 8 is a close-up view of the condition of the running gear at 4:08 p. m. While this photograph was being taken, the mechanic and his helper were underneath the engine putting up the binders and setting up the binder bolts preparatory to lifting the engine off from the wheeling pit. The last photograph of the series is shown in Fig. 9 taken at 4:12 p. m. Here locomotive No. 637 is being lifted up from the wheeling pit to be moved to the spot in the finishing section where the final work will be performed on the engine preparatory to leaving the shop in service condition.

It is, perhaps, well to direct attention at this point to the fact that the wheeling operation just described involves only the application of the wheels to the locomotive. This, of course, necessitates the putting up of the binders and the shoes and wedges but it does not include the application of the main rods, the application of the brake rigging or the final adjustment of the shoes and wedges or the side-rod knuckle-pin nuts. This work is performed in the finishing section. (Section I of the shop.)

This section, as previously explained, takes in both stripping operations on the inbound track and the finishing operations on the outbound track. In this section is also included the work that is done outside of the shop such as final testing, inspecting, firing-up and equipping for service.



Arrangement and location of departments and routing of materials and parts in the B. & O. shops at Glenwood, Pa.

Defective Locomotives Continue Decline

By A. G. Pack

The nineteenth annual report of the Bureau of Locomotive Inspection to the Interstate Commerce Commission, shows steady improvement since 1923 and best record since 1916

ONLY 16 per cent of the locomotives inspected during the fiscal year ending June 30, 1930, were found defective according to the nineteenth annual report of A. G. Pack, chief inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission. In addition, the report showed a decrease in the number of accidents and the number of persons killed or injured. Only 16 per cent of the locomotives inspected were found defective. There were 295 accidents which resulted in 333 casualties. This is the best record ever attained by the railroads since 1916, when the Bureau of Locomotive Inspection first began the compilation of statistics pertaining to the inspection of locomotives as they are now reported. There has been a steady decline in the number of defective locomotives, accidents and casualties since 1923, when 65 per cent of the locomotives inspected by federal inspectors were found defective, and there were 1,348 accidents which resulted in 1,632 casualties. Following is an abstract of Mr. Pack's report:

During the year 16 per cent of the locomotives inspected were found with defects or errors in inspection that should have been corrected before being put into use as compared with 21 per cent for the previous year. A summary of all accidents and casualties to persons occurring in connection with steam locomotives compared with the previous year shows a decrease of 17.1 per cent in the number of accidents, a decrease of 31.6 per cent in the number of persons killed, and a decrease of 17.9 per cent in the number injured during the year.

The decrease in accidents and casualties brought about by the decrease in defective locomotives, and the converse, are illustrated graphically by the curves on the chart.

Some of the carriers are maintaining their locomotives in condition approaching perfection while others are delinquent in this respect. The average percentage of locomotives on all railroads found defective has steadily decreased over a period of years reaching the low point of 16 per cent for the year ended June 30, 1930. Improved standards of maintenance reflected by the reduced percentage of defective locomotives have brought about the greatest degree of safety of locomotive operation ever attained.

Boiler Explosions or Crown-Sheet Failures

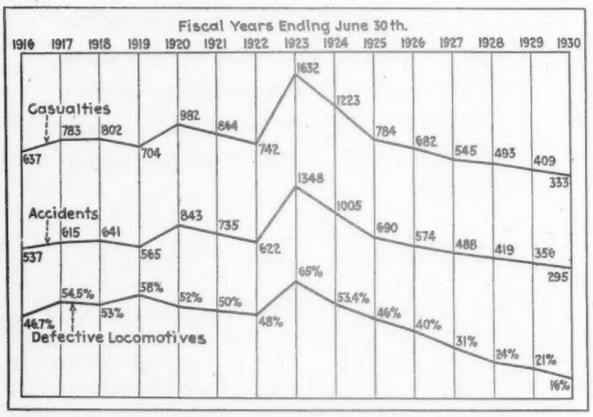
Boiler explosions caused by crown-sheet failures continue to be the most prolific source of fatal accidents; 84.6 per cent of the fatalities during the year were attributable to this cause as compared with 68 per cent in

A crack at the edge of a fusion weld in a crosshead on a locomotive about to be placed in service

Number of Steam Locomotives Reported, Inspected, Found Defective and Ordered From Service

Parts defective, inoperative or missing, or in violation of rules	Year ended June 30					
	1930	1929	1928	1927	1926	1925
1. Air compressors	873	1,202	1,282	1,679	2,151	1,574
2. Arch tubes	87	104	103	127	204	198
3. Ash pans and mechanism	76	132	133	192	211	216
4. Axles	12	20	7	13	8	14
5. Blow-off cocks	325	442	469	650	780	825
6. Boiler checks	521	761	914	1,043	1,200	991
7. Boiler shell	579	841	954	1,422	1,888	1,597
8. Brake equipment	2,706	3,894	5,214	6,572	7,062	6,497
9. Cabs, cab windows, and curtains	3,066	2,140	1,670	2,055	2,666	2,541
10. Cab aprons and decks	710	1,005	852	1,086	1,307	1,165
11. Cab cards	226	305	378	575	696	665
12. Coupling and uncoupling devices	122	154	179	289	394	447
13. Crossheads, guides, pistons, and piston rods	1,421	1,887	2,088	2,602	3,018	2,922
14. Crown bolts	95	129	164	235	334	283
15. Cylinders, saddles, and steam chests	2,311	3,210	3,264	4,526	5,080	4,352
16. Cylinder cocks and rigging	848	967	1,007	1,634	1,904	1,801
17. Domes and dome caps	154	227	281	388	463	371
18. Draft gear	950	1,310	1,453	2,037	2,634	2,283
19. Draw gear	1,003	1,367	1,650	2,210	3,140	3,273
20. Driving boxes, shoes, wedges, pedestals, and braces	1,359	1,993	1,990	2,710	3,342	3,241
21. Fire-box sheets	471	657	730	796	1,129	1,152
22. Flues	254	334	464	465	556	524
23. Frames, tailpieces, and braces, locomotive	1,271	1,377	1,354	1,682	1,973	2,036
24. Frames, tender	177	297	256	264	373	391
25. Gauges and gauge fittings, air	290	309	461	721	886	694
26. Gauges and gauge fittings, steam	553	678	969	1,425	2,038	1,809
27. Gauge cocks	783	1,114	1,413	2,024	3,068	3,081
28. Grate shakers and fire doors	767	295	377	613	720	832

29. Handholds	865	1,125	1,373	2,285	3,100	2,831
30. Injectors, inoperative	103	86	93	84	78	70
31. Injectors and connections	3,275	4,484	5,563	7,188	8,303	8,064
32. Inspections and tests not made as required	7,456	9,246	6,623	8,889	10,646	10,436
33. Lateral motion	372	618	699	673	758	659
34. Lights, cab and classification	119	121	118	107	106	86
35. Lights, headlights	373	488	571	835	946	928
36. Lubricators and shields	312	423	500	746	883	704
37. Mud rings	445	636	822	1,073	1,458	1,384
38. Packing nuts	828	991	1,265	1,851	2,772	2,761
39. Packing, piston rod and valve stem	1,429	1,708	1,904	2,214	2,489	2,411
40. Pilot and pilot beams	272	371	386	507	638	832
41. Plugs and studs	348	482	619	740	1,087	849



Relation of defective locomotives to accidents and casualties resulting from locomotive failures

42. Reversing gear	579	788	967	1,247	1,539	1,274
43. Rods, main and side, crank pins, and collars	2,488	3,465	4,152	5,137	5,683	4,813
44. Safety valves	116	170	172	212	270	234
45. Sanders	804	1,008	1,031	1,268	1,769	2,004
46. Springs and spring rigging	3,311	4,557	4,939	5,956	6,826	5,536
47. Squirt hose	313	387	478	644	975	1,008
48. Stay bolts	395	542	590	631	905	741
49. Stay bolts, broken	1,098	1,197	1,867	2,373	3,582	3,745
50. Steam pipes	730	925	1,020	1,308	1,587	1,590
51. Steam valves	399	471	708	774	962	869
52. Steps	1,021	1,394	1,817	2,440	3,227	2,867
53. Tanks and tank valves	1,426	1,717	1,941	2,747	3,430	3,352
54. Telltale holes	183	174	241	377	487	451
55. Throttle and throttle rigging	1,175	1,554	1,889	2,233	2,618	2,403
56. Trucks, engine and trailing	1,141	1,605	1,914	2,363	2,860	2,966
57. Trucks, tender	1,531	2,144	2,610	4,114	4,929	5,372
58. Valve motion	827	1,067	1,262	1,568	1,576	1,250
59. Washout plugs	1,283	1,871	2,211	2,786	3,649	3,588
60. Train control equipment	48	60	112	....	....	....
61. Water glasses, fittings, and shields	1,501	1,816	2,115	2,973	3,621	3,713
62. Wheels	1,025	1,325	1,609	2,119	2,243	2,148
63. Miscellaneous—Signal appliances, badge plates, brakes (hand)	691	1,101	1,273	1,511	1,746	1,529
Total number of defects	60,292	77,268	85,530	112,008	136,973	129,239
Locomotives reported	61,947	63,562	65,940	67,835	69,173	70,361
Locomotives inspected	100,794	96,465	100,415	97,227	90,475	72,279
Locomotives defective	16,300	20,185	24,051	29,995	36,354	32,989
Percentage of inspected found defective	16	21	24	31	40	46
Locomotives ordered out of service	1,200	1,490	1,785	2,539	3,281	3,637

Vertical member of the boiler connection to the bottom of the water column filled solid with hard scale found on a locomotive about to be placed in service

the previous year. However, there was a decrease of 35.3 per cent in the number of such accidents, a decrease of 15.3 per cent in the number of persons killed, and a decrease of 35 per cent in the number of persons injured as compared with the previous year.

The increasing size of locomotive boilers and the high pressures carried therein tend to increase the violence of explosions and cause increase in the fatalities per accident and increase in the seriousness of injury to those who are exposed and survive. Attention is directed to the necessity for the use of the safest and strongest practicable firebox construction, including the use of reliable boiler feeding and water level indicating devices. These questions have been referred to in my former annual reports in order that the number of this class of accidents and the effects thereof might be minimized.

Extension of Time for Removal of Flues

Two hundred and eighty-two applications were filed for extensions of time for removal of flues, as provided in Rule 10. Our investigations disclosed that in 12 of these cases the condition of the locomotives was such that extensions could not properly be granted. Nineteen were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Forty-four extensions were granted after defects disclosed by our investigations had been repaired. Twenty-seven applications were canceled for various reasons. One hundred and eighty applications were granted for the full periods requested.

Specification Cards and Alteration Reports

Under Rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 1,242 specification cards and 7,500 alteration reports were filed, checked, and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constructed or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found.

Under Rules 328 and 329 of the Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam, 70 specifications and 123 alteration reports were filed for locomotive units and 23 specifications and 6 alteration reports were filed for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found.

Suits for Penalties

Eleven suits for penalties, involving 241 counts for alleged violations of the Locomotive Inspection Law and Rules, were pending in the various district courts at the beginning of the year. Information of violations was lodged with the proper United States attorneys in three cases, involving 39 counts. Judgments in favor of the Government were obtained in 11 cases, involving 236 counts; 107 counts were dismissed by stipulation or

(Concluded on page 26)

High-Pressure Steam for Locomotives

By C. F. Hirshfeld*

IT is natural that in considering any radical change from past practice, designers should give thought to what has happened in more or less parallel fields, as for instance in that of the stationary power plant. Such developments may or may not be applicable to the plant required to move about as does a locomotive, but the facts cannot be determined except by analysis and possibly also by experiment.

When the locomotive designer begins to study recent stationary-plant development he discovers marked increases of steam pressure during a comparatively short period, and latterly an evident tendency toward radical increases of steam temperature. It is but natural to ask whether these are proper items for serious consideration in his field of endeavor.

In stationary practice there are two radically different conditions leading to the use of high steam pressure. The first is the higher thermal economy obtainable in condensing plant. The second is the greater quantity of power obtainable from steam expanded in engine or turbine and then exhausted, at pressures near or above atmospheric, for process or heating purposes. Such reasons have underlain an increase of average steam pressure from about 180 lb. gage in 1900 through 200 lb. gage about 1913 to about 450 to 500 lb. gage today with increases to 1,400 and 1,800 lb. in a few exceptional cases. The average steam pressure in representative locomotives is today about 220 lb. gage, with a pressure of about 280 lb. as the highest normal value. Higher pressures are in use, but may still be regarded as more or less experimental. The figure of 280 corresponds to the value reached in stationary practice in exceptional cases about 15 years ago, and in common use about ten years ago. I still remember the shaking of heads that accompanied the first increases above that value.

Erroneous Beliefs as to Thermal Economy

There is a popular belief that thermal economy increases indefinitely with increasing steam pressure and this belief has been responsible for quite a bit of loose thinking. Comparatively simple calculations suffice to show that it is erroneous.

The thermal economies obtainable with various steam pressures and temperatures in condensing operation are shown in a convenient way in Table I. In preparing this table certain assumptions were required; it is not believed necessary to recite them here.

Suffice it to say that they were so made that the figures given are directly comparable, and that these figures give conservative values for well-operated turbine equipment of moderately large size as found throughout the country.

A brief survey of these figures will show what appear to be extraordinarily good performances for low-pressure, low-temperature plants. The figures are believed to be approximately correct in this respect. They reflect the fact that during the progress to higher pressures and temperatures we have made other improvements in plant design. If these improvements were carried back to the low-pressure plant, the performance of the latter would be much better than the performances mentally associated with such pressures. This is a fact which should not be overlooked; at least a good part of the credit that has been given popularly to higher steam pressures in modern plants belongs properly to improved plant design.

For the purpose of indicating both the thermal advantages and limitations of higher pressures and temperatures in condensing operation, a few numerical relations will be considered. Take, for example, the decreased heat consumption resulting from the increase of pressure at a given temperature and using the Rankine cycle, that is, without regenerative heating. These values, taken from Table I, are plotted in Fig. 1, using steam at various pressures but at a single temperature, namely, 700 deg. F. As a matter of fact the curve is partly non-realizable because beyond about 500 lb. initial pressure the water content of the steam at and near exhaust pressures would become too great to be economically usable with available turbine equipment. It is at once apparent that the great improvement with increasing pressure occurs in the lower ranges for such conditions as are indicated in Fig. 1, and that there is a reversal, that is, an actual loss if the pressure is carried high enough. It is questionable whether any pressure higher than 500 to 600 lb. could be justified for such conditions. A higher initial temperature

Progress Depends On Leadership

"Some thirty-odd years ago the stationary-plant engineer began a march of progress which probably represents one of the most remarkable advances ever made in a like period. It happens that my life in the capacity of wage earner started at about the beginning of this period, and that a teaching experience of some years caused me to become familiar with the history of power-plant engineering in the preceding period.

"The combination has often led me to contrast mentally the radically different rates of progress and to speculate as to the cause of such differences. At first I saw the cause in the development of this or that piece of equipment, but I have finally come to realize that the basic cause was a change in the outlook of the human beings who served as leaders. I am convinced that when the progress of stationary-plant engineering during the first third of the present century is viewed in retrospect, the most striking characteristic will be found to be the willingness of the leaders to cut loose from the past and to try new things, to strike out boldly into unexplored fields."

* Mr. Hirshfeld is chief of the Research Department, The Detroit Edison Company, Detroit, Mich. He contributed this paper, of which an abstract and a summary of the ensuing discussion is given here, at the invitation of the Railroad Division, A. S. M. E., during the annual meeting of the society, which was held in New York, December 1 to 5, 1930, inclusive.

would alter the conditions slightly. With an initial temperature of 1,000 deg. F. there would be a continuous improvement up to and including 2,000 lb., but the total reduction in passing from 1,000 to 2,000 lb. would be only 350 B.t.u. as against almost 2,000 B.t.u. in passing from 200 to 1,000 lb.

A great part of the saving that is achieved through the use of high-pressure steam in condensing stationary

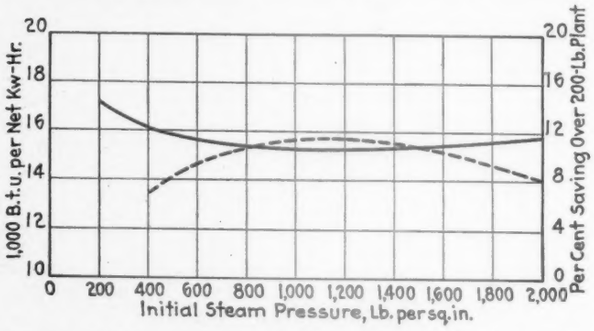


Fig. 1—Solid curve shows station-heat rate; Rankine cycle—No regenerative feed heating; Steam at 700 deg. F.—Broken curve shows per cent saving over 200-lb. plant

practice is achieved through the use of regenerative feedwater heating. The higher the pressure, the greater the effect of this process. Thus, using figures from Table I, the saving resulting from regenerative heating in four stages at 200 lb. and 700 deg. F. is 1,410 B.t.u., whereas at 2,000 lb. and 700 deg. F. it is 2,274 B.t.u. However, even with regenerative feedwater heating, the gains obtainable with like pressure increments become increasingly smaller as the pressure increases and ultimately reverses. This is shown in Fig. 2, which corresponds to Fig. 1. Comparison of the percentage curves of the two figures will show the effect of regenerative feed heating in increasing the saving resulting from increased steam pressure.

Inspection of these curves indicates that at 700 deg. F. there is probably little justification in exceeding about 600 lb. without regenerative heating and something like 800 to 900 lb. with four-stage regeneration, unless reheating be resorted to. In practice the limits are set in both cases close to 500 lb. because of the serious effect of condensate in the steam. The situation is naturally improved by increasing the initial temperature. If 1,000-deg. F. steam could be used, the practical or commercial upper-pressure limit without reheating would probably be in the neighborhood of 1,000 lb.

The question of whether condensing operation is possible or desirable with steam locomotives appears to be unanswered as yet. If the experiments that are now being made with condensing turbine-driven locomotives should prove such construction to be commercially feasible, the figures just given may serve to indicate the extent to which steam pressure may be profitably carried when viewed with respect to thermal considerations only.

There are, however, other considerations which may also be weighty, particularly in the case of locomotives. Thus, for example, high-pressure steam occupies much less space per unit of weight than does saturated steam. One pound of steam at 200 lb. absolute and 700 deg. F. occupies a space of 3.4 cu. ft., whereas the same weight at the same temperature, but at a pressure of 1,400 lb., occupies only 0.4 cu. ft. As a result of this fact, pipes and other parts for high-pressure steam may in fact weigh less than for the equivalent amount of low-pressure steam. Many peculiar effects follow from this and other characteristics of high-pressure steam, and it is almost certain that the thermal savings will not be completely determinative.

When non-condensing operation is considered we obtain an entirely different sort of picture from that disclosed above. I shall present it as it appears when considered with respect to industrial plants in which steam is exhausted for process purposes. You who are more familiar than I with the locomotive engine can translate my figures easily to the terms in which you deal.

Numerical values for this condition are given in

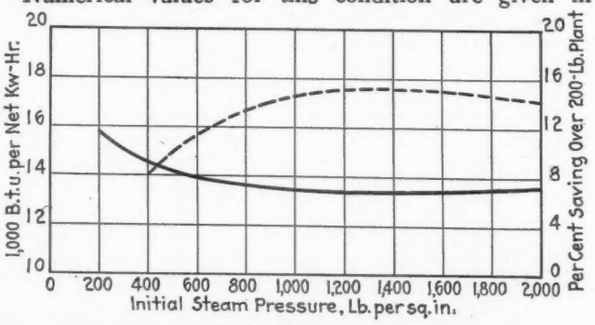


Fig. 2—Solid curve shows heat rate with four stages of regenerative feed heating and steam at 700 deg. F.—Broken curve shows per cent saving over 200-lb. plant

Tables II and III, and certain of the tabulated numbers and values obtained therefrom are shown in Figs. 3, 4, and 5. It should be noted that these values are developed for steam-turbine plant, and that large and small units, respectively, are considered. In reciprocating plant running under conditions of greatest economy the values would probably lie between those shown for the two sizes chosen.

The significant figures for non-condensing operation are those plotted in Figs. 3 and 4, giving the net output per 1,000 lb. of steam expanded down to 5 lb. gage pressure. Even at the low initial temperature of 700 deg. F., Fig. 3, an increase of output of over 20 per cent is obtained from a given weight of steam by raising the initial pressure from 200 to 400 lb. It is particularly interesting to note the comparatively small gains resulting from increasing the initial pressure above 800 lb., even at comparatively high initial temperatures.

A Comparison

"Looking at the steam locomotive through the eyes of an engineer who has concentrated his efforts in the stationary field, I am struck by the fact that it appears to have improved little during the period in which my own field of endeavor has made such rapid progress. To be sure, it has been made bigger, super-heaters have been adopted, feedwater heaters have been added, and so on, but the locomotive that I viewed with wonder as a small boy and the locomotive that I view more understandingly as a middle-aged man are essentially the same."

Decrease in Engine Size With Increase of Pressure

The curves given in Fig. 5 probably put this matter in somewhat more significant fashion for the locomotive designer. These curves show the decrease in "engine size" with increase of pressure. In this case this means area through the last set of blades and volume of exhaust casing. In the case of a reciprocating engine it would correspond roughly to piston displace-

ment under conditions of minimum cut-off. It will be noted that the decreases in engine size are really significant, and it should be remembered that similar or greater decreases occur in all steam-carrying parts. It will also be noted that the greater part of the decrease is attained in most cases by the time a pressure of 600 to 800 lb. is reached.

It is at least conceivable that the combination of decreased fuel consumption per unit of output and the decreased volume might be used in locomotive practice in either one of two ways. One would be the increase of capacity without increase of grate area or its equivalent; the other would be decreased size of parts for pres-

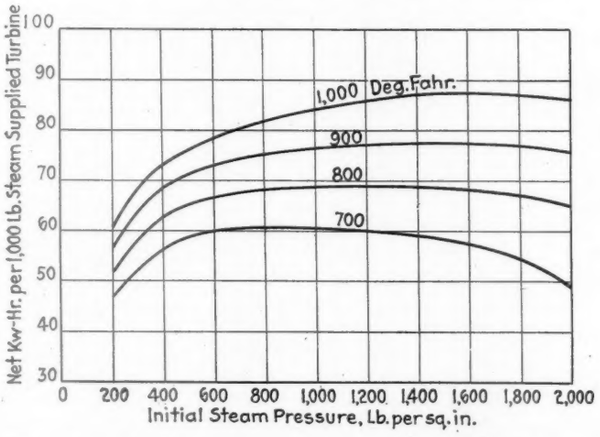


Fig. 3—Net power made available from a given weight of steam at various initial conditions and 5 lb. per sq. in. back pressure—Feedwater heated to 212 deg. F.—Large turbine plant (20,000-kw. units)

ent output. It would take more technical knowledge of the field than I possess to evaluate the significance of such possibilities. I shall have accomplished my end if I have shown you that, even in such simple matters as thermal performance and output per pound of steam, the situation is highly complicated and requires detailed study; that it is quite erroneous to assume that improvement in these respects must necessarily follow increase of steam pressure or temperature.

It should be helpful to consider what may be expected if theoretical considerations along such lines as are suggested above should show that radical increases of pressure and temperature promise worthwhile results in locomotive practice. Enough has been said to indicate that initial temperature is closely bound up with initial pressure in turbine practice. The same thing is true to some extent in reciprocating-engine practice, even in non-condensing operation. Therefore the consideration of permissible initial temperature appears to be the logical starting point.

Temperature Limitations Imposed by Metals

Experience with steam superheated above a temperature of 750 deg. F. is still too meager to make it safe to draw final conclusions with respect to higher temperatures. At present it looks as though carbon-steel tubes can be used safely to produce steam with a temperature of 800 to 850 deg. F., provided the metal temperature does not rise too high. The limit in this respect is taken at present at about 950 deg. F. provided the steam is practically free of oxygen when it reaches the superheater tubes. It is also necessary to design so that the unit stresses in the metal do not exceed something of the order of 4,000 lb. per sq. in.

The importance of oxygen-free steam cannot be ignored as experience indicates that very rapid attack upon the metal may be expected at such metal temperatures if any appreciable quantity of oxygen is present in the steam.

This is also the temperature at which reaction between iron and steam begins to become noticeable. As a matter of fact, this reaction does not occur to a sufficient extent at 950 deg. F. to be at all significant, but it becomes of great importance at between 1,000 and 1,050 deg. F. The reaction is such that a very closely adherent magnetic-oxide scale is formed on the steam side of the tube and hydrogen passes off with the steam.

Higher temperatures may be used with alloy steels such as the nickel-chromium alloys and others which show higher creep strengths than the carbon steels. Such metals have been used in experimental equipment delivering steam at 1,100 deg. F., and there is no indication of short life due to creep, simple oxidation, or reaction with steam. Unfortunately the available alloys are all very high priced, and their metallurgy and physical behavior are not yet well understood.

These facts would seem to indicate that we are limited to steam temperatures of the

Table I—Thermal Performance of Condensing-Turbine Plant

Steam pressure, lb. per sq. in. abs.	Steam temperature, deg. fahr.	Station heat rate, B.t.u. per net kw-hr. Rankine cycle (no regenerative heating)	Regenerative cycle: First stage feed heating	Second stage feed heating	Third stage feed heating	Fourth stage feed heating
200	700	17,170	16,230	15,980	15,840	15,760
200	800	16,420	15,590	15,330	15,220	15,120
200	900	15,800	15,000	14,740	14,630	14,560
200	1000	15,220	14,460	14,230	14,120	14,030
400	700	16,030	15,050	14,770	14,610	14,490
400	800	15,370	14,460	14,200	14,040	13,940
400	900	14,770	13,920	13,680	13,530	13,440
400	1000	14,240	13,450	13,220	13,090	13,000
600	700	15,580	14,520	14,230	14,070	13,960
600	800	14,900	13,930	13,660	13,500	13,390
600	900	14,320	13,420	13,170	13,020	12,920
600	1000	13,800	12,970	12,730	12,590	12,500
800	700	15,360	14,250	13,940	13,770	13,650
800	800	14,640	13,620	13,340	13,170	13,060
800	900	14,050	13,110	12,840	12,690	12,590
800	1000	13,530	12,650	12,410	12,260	12,170
1000	700	15,240	14,080	13,760	13,570	13,450
1000	800	14,480	13,420	13,120	12,950	12,840
1000	900	13,380	12,910	12,630	12,470	12,360
1000	1000	13,350	12,440	12,190	12,040	11,940
1200	700	15,210	14,000	13,670	13,490	13,370
1200	800	14,420	13,130	13,010	12,840	12,730
1200	900	13,760	12,750	12,460	12,310	12,200
1200	1000	13,210	12,270	12,010	11,870	11,770
1400	700	15,270	14,010	13,670	13,490	13,360
1400	800	14,360	13,230	12,910	12,750	12,630
1400	900	13,690	12,660	12,370	12,210	12,110
1400	1000	13,120	12,160	11,890	11,750	11,660
2000	700	15,780	14,300	13,910	13,710	13,560
2000	800	14,500	13,260	12,920	12,760	12,620
2000	900	13,610	12,520	12,220	12,040	11,930
2000	1000	13,000	11,990	11,710	11,570	11,470

Necessary to Reconsider Problem

"If one may judge from the presently evident movements in the field, the economic conditions have altered to such an extent that basic changes in locomotive design are felt to be necessary. If this be the case, designers will have to bestir themselves and acquire a new point of view. No longer will it be sufficient to improve by whittling here and adding there. It will be necessary to consider the whole problem *de novo*, to depart temporarily from all the traditions of the past, to let the imagination have free rein in team with analytical ability. What will evolve may possibly be guessed at; it certainly cannot be predicted."

order of 800 to 850 deg. F. if restricted to carbon-steel tubing, and that we can probably extend this temperature to 1,000 or 1,100 deg. if the cost of the more expensive alloys can be justified. These figures immediately enable us to determine the highest steam pressures that show thermal advantages under any selected set of conditions. It must be realized, however, that the thermal considerations alone are not completely determinative. There are many others of operating and economic character which are equally important, and much more difficult to evaluate with respect to any particular field.

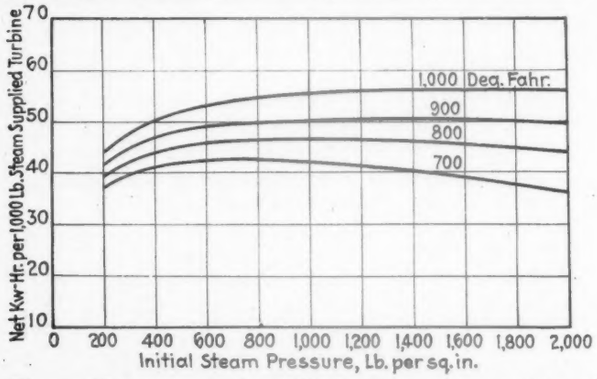


Fig. 4—Net power made available from a given weight of steam at various initial conditions and 5 lb. per sq. in. back pressure—Feedwater heated to 212 deg. F.—Small turbine plant (2000-kw. units)

Boiler Characteristics at High Pressures

If one choose about 800 deg. F. as the highest temperature which now seems reasonably possible under locomotive conditions, it would appear from thermal considerations as though a pressure in the neighborhood of about 800 lb. might be usable for non-condensing operation. It becomes pertinent to inquire into boiler characteristics at such pressures. Stationary experience with the higher pressures has been had with water-tube boilers exclusively, and with comparatively clean and pure boiler water. It is a long cry from such conditions to those found in average locomotive practice.

With properly designed water-tube boilers there has been no evidence of any intrinsic limitations to adequate natural circulation at pressures in the neighborhood of 600 to 700 lb., and there is no reason to expect such trouble at 800 lb. On the other hand, when pressures of 1,200 to 1,400 lb. are reached, the forces causing natural circulation appear to be approaching such magnitudes that very small changes of design or condition may lead to serious trouble.

In this country we have succeeded in obtaining commercially satisfactory operation at such pressures with water-tube boilers of what one may call conventional design, but it has required careful design and careful operation. European engineers, on the other hand, calculated in advance the forces that should be available for creating natural circulation, and concluded that somewhere in the neighborhood of 1,200 to 1,400 lb. one entered the questionable region. It is possible that this is responsible for some or all of the radically new types of high-pressure steam-producing equipment now being experimented with in Europe.

Speaking first in general terms, the temperature of

Table II—Thermal Performance of Non-Condensing-Turbine Plant—Large Turbines Exhausting at 5 lb. Gage

Steam pressure, lb. per sq. in. abs.	Steam temperature, deg. F.	B.t.u. per net kw-hr.	Net kw-hr. per 1000 lb. steam supplied
200	700	32,500	46.3
200	800	31,250	51.3
200	900	29,750	56.3
200	1000	28,000	60.8
400	700	26,750	56.0
400	800	25,650	62.3
400	900	24,650	68.3
400	1000	23,500	73.4
600	700	24,500	60.0
600	800	23,250	66.7
600	900	22,400	73.2
600	1000	21,250	78.7
800	700	24,000	60.5
800	800	22,500	68.5
800	900	21,650	75.5
800	1000	20,500	82.2
1000	700	23,900	60.4
1000	800	22,250	68.7
1000	900	21,200	76.4
1000	1000	20,000	84.5
1200	700	23,900	60.0
1200	800	21,850	68.9
1200	900	20,850	77.0
1200	1000	19,650	86.2
1400	700	24,200	59.2
1400	800	22,000	68.7
1400	900	20,750	77.4
1400	1000	19,400	87.0
2000	700	27,550	49.0
2000	800	22,500	65.0
2000	900	20,750	75.7
2000	1000	19,200	87.0

Table III—Thermal Performance of Non-Condensing-Turbine Plant—Small Turbines Exhausting at 5 lb. Gage

Steam pressure, lb. per sq. in. abs.	Steam temperature, deg. F.	B.t.u. per net kw-hr.	Net kw-hr. per 1000 lb. steam supplied
200	700	40,650	37.1
200	800	40,000	39.3
200	900	39,250	41.8
200	1000	38,750	44.2
400	700	36,250	41.2
400	800	35,750	44.0
400	900	35,000	47.0
400	1000	33,900	50.3
600	700	35,000	42.5
600	800	34,000	45.9
600	900	33,250	49.0
600	1000	32,000	53.2
800	700	34,500	42.5
800	800	33,250	46.5
800	900	32,250	49.7
800	1000	31,000	54.7
1000	700	34,500	42.2
1000	800	32,900	46.6
1000	900	31,750	50.0
1000	1000	30,250	55.5
1200	700	34,750	41.5
1200	800	32,750	46.5
1200	900	31,350	50.3
1200	1000	29,900	56.0
1400	700	35,200	40.5
1400	800	32,750	46.2
1400	900	31,250	50.5
1400	1000	29,700	56.3
2000	700	37,000	36.5
2000	800	33,400	44.3
2000	900	31,500	50.0
2000	1000	29,500	56.0

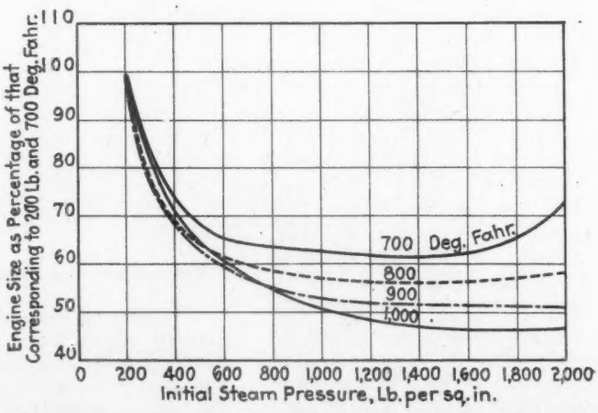


Fig. 5—Effect of initial steam conditions on physical size of engine—Large turbine plant—5 lb. per sq. in. back pressure

saturated steam rises with its pressure. Thus, even though the metal surfaces be scrupulously clean on the water side and even though we assume the same thickness of metal in all cases, the average temperature of the boiler metal increases as the pressure under which steam is generated increases. It is also true that with similar structures the metal thickness would increase with pressure, so that at a given rate of heat transfer its average temperature would also increase slightly because of the slightly greater temperature drop through the metal. It is also obvious that an increasing rate of heat transfer through the metal must correspond to an increasing temperature drop through that metal and thus to a higher average metal temperature.

In stationary practice and with clean water no limit to increase of pressure has yet been set by such phenomena. However, two things of interest have been uncovered. An almost unbelievably small amount of scale on the water side in 1,200 to 1,400-lb. pressure boilers is fatal to those surfaces subjected to high rates of heat transfer. And it is possible to show by calculation that, with heat-transfer rates which may be regarded as possible of achievement, the metal of exposed tubes in a 1,400-lb. pressure boiler may reach temperatures at which the existing stresses will cause fairly rapid creep.

If one may judge from such meager evidence, it would seem that even if the locomotive boiler were modified structurally so as to adapt it to use with pressures of this order of magnitude, the feedwater conditions now characteristic of locomotive practice would make operation at such pressures impossible. In fact, I greatly doubt whether operation at a pressure as low as 400 lb. could be conducted commercially without great improvement over present feedwater practice as it exists throughout the country.

Feedwater Problem One of the Most Important

Looking at this field from the outside, I am impressed with the feedwater problem as one of the important ones that must be solved before any great advance of pressure can be contemplated safely. The situation of the railroads in this respect appears to me to be similar to that of the stationary plant of the better sort only a comparatively short time ago. It is only 17 years since the first equipment for supplying distilled make-up in condensing stationary plants was installed, and even now we are only beginning to understand the treatments required in cases in which we cannot return an adequate supply of condensate. I confess that I do not know just how the problem should be handled in railroad practice, but I am convinced that some better solution than that now in hand must be found before great increases in steam pressure can be safely contemplated for general use. It may be possible that the savings of various sorts that may be made through the use of higher pressures will be found sufficient to justify large, well-distributed feedwater-treatment plants, with transportation of treated water to various intermediate supply points. Or it may be that sufficiently skillful chemists can develop more perfect and simplified treatments which can be applied on the individual locomotive with such talent as is available in its operating crew. Or it may be that condensing operation will be found feasible, even though condensation be conducted at or near atmospheric pressure. I leave such considerations to those sufficiently skilled in the economics of railroading. But I do feel that the crux of the problem lies right in this factor, and that solution calls for radical thinking, for a deliberate reorientation and a new attack upon the problem.

I am also convinced in my own mind, possibly because of my ignorance with respect to the details of the problem, that the present type of locomotive boiler must pass out if much higher pressures are to be used with the maximum of economic results. Much as I admire the peculiar fitness of the present type, I cannot but feel that it represents one of those things which, surviving through its peculiar fitness, has served to limit the possibilities of improvement of major character. We have been through this thing in the stationary field and in the marine field, and it is possibly only natural to assume that we may expect a parallel development in the railway field.

Possible Locomotive Development for High Pressures and Temperatures

I have even been so bold on occasion as to endeavor to picture just what sort of boiler I would design for a high-pressure locomotive if that problem were put up to me. That it must have a water-cooled firebox is almost self-evident. That the water-cooled surfaces should take the form of tubes for high pressure instead of plates is almost equally obvious. I suspect also that the conditions of use are such that a large reservoir of steaming ability must be available in some form. Beyond these rather rudimentary specifications one would appear to have a very clear field, provided always that the problem of a satisfactory feedwater supply can be solved.

Such thought as I have given to the matter always brings me back to substantially the same picture, which I give you for what it may be worth. I conceive first of a rather large reservoir which shall be adapted to hold a volume of water substantially at boiler temperature and which shall serve as a source of steam supply to meet sudden short-time demands. Associated with this reservoir is a system of water tubes serving as a water-tube boiler. These form the firebox and, besides, give such added surface as is required to reduce the products of combustion to an acceptable temperature. Circulation through these tubes is produced by a pump which draws from the hot-water reservoir, and the tubular surface is so arranged as to discharge to that reservoir. The water tubes simply serve as a collection of heating paths starting at the pump discharge and ending at the pump suction, i.e., the reservoir from which the pump draws. Steam made is tapped off this heating system as required. I imagine that the pump speed will be regulated with respect to steam demand so that it will always circulate a large excess of water.

This may appear to you to represent very radical thinking. In one sense it is. In another, it represents a fairly logical mental extension of the path that we have followed in stationary practice. Whether it has any merit other than that of provoking comment and thus the exercise of the imagination, I know not. I do know that the imaginable solutions of the problem are so numerous that it is almost a foregone conclusion that our present one is not in all respects the best one, particularly when one considers its age and the air of assured respectability that age has conferred upon it.

One familiar with locomotive design will undoubtedly view with alarm the steam temperatures that have been suggested as desirable with higher pressures. Even a temperature of 800 to 850 deg. F. is not a pleasant thought in connection with locomotive engines of present design. But, once more, assuming that we retain the reciprocating engine, is the present design a necessary result? I think not.

It is almost certain that some type of poppet-valve mechanism will have to be substituted for the present types in which metal slides on metal. But I cannot see that this necessarily offers insurmountable difficulties.

Cylinder lubrication, as we now understand it, will also have to be abandoned. It is at least possible to conceive of a design of piston reciprocating in a cylinder which does away with actual metallic contact between these parts and, thus, with the necessity for cylinder lubrication of any sort. Guiding and support of the piston would then have to be taken care of externally and two packings would be required. Incidentally, packing against steam at high pressure and at a temperature of 800 deg. F. is no mean problem but even here promising solutions are now imaginable.

If we cut loose from present designs and adopt the condensing turbine solution, many of these problems disappear, but others of equal or greater magnitude make their appearance. However, they do not seem to me in my ignorance to be more difficult than many that have been solved successfully in other fields in recent years by the simple method of breaking completely from the conventional and considering all possibilities without too great reference to past convictions.

It seems necessary to call attention to one other feature of high-pressure plant that has not been touched on. The values given in Tables I, II, and III and illustrated in several figures were calculated on the basis of a constant boiler-plant efficiency. This involved an assumption which is important in the present consideration. This assumption was that the tendency of the temperature of the flue gases discharged from the boiler to rise with increase of steam pressure, due to the increased saturation temperature, was balanced by the proper addition of heat-absorbing surface of some form. A similar problem will develop in locomotive practice if very high pressures are resorted to. It may be that the economics of the situation will prove to be such that a net gain may result from the use of higher steam pressure in spite of a greater loss to the stack. On the other hand, it may prove necessary to install auxiliary heat-absorbing equipment, such as economizers or air preheaters. The facts can be determined only by a most detailed analysis and possibly by later experiment.

Discussion

H. B. Oatley, vice-president, Superheater Company, New York, complimented Dr. Hirshfield for recognizing the natural limitations imposed upon the locomotive-power plant. He agreed that the conventional form of locomotive boiler had nearly reached the limit of its usefulness and referred to the flat stayed surfaces of the firebox as a type of construction which should be scrapped for steam pressures above 300 lb. In lieu thereof, Mr. Oatley suggested the use of the water-tube firebox. He agreed with the author that high pressures will save weight.

James M. Taggert, consulting engineer, New York, also pointed out the unsuitability of the fire-tube boiler for use in connection with high pressures. He proposed the application of an economizer and air heaters. Mr. Taggart stressed the importance of giving serious consideration to the ultimate utilization of pulverized coal.

Prof. A. J. Wood, head of the mechanical-engineering department, Pennsylvania State College, defended the efficiency of the locomotive of conventional design. In his remarks he briefly reviewed the developments of a steam locomotive in recent years and stressed the fact that considerable had been accomplished within limitations which were well recognized.

A. A. Potter, dean of the school of engineering, Purdue University, announced that the Babcock & Wilcox Company is delivering an experimental boiler designed to operate at pressures ranging from 3,500 lb. to 4,500 lb. and a temperature of 833 deg. F. to the experimental laboratory at Purdue. The steaming capacity of this boiler is estimated at 5,000 lb. per hr.

Defective Locomotives Continue Decline

(Continued from page 20)

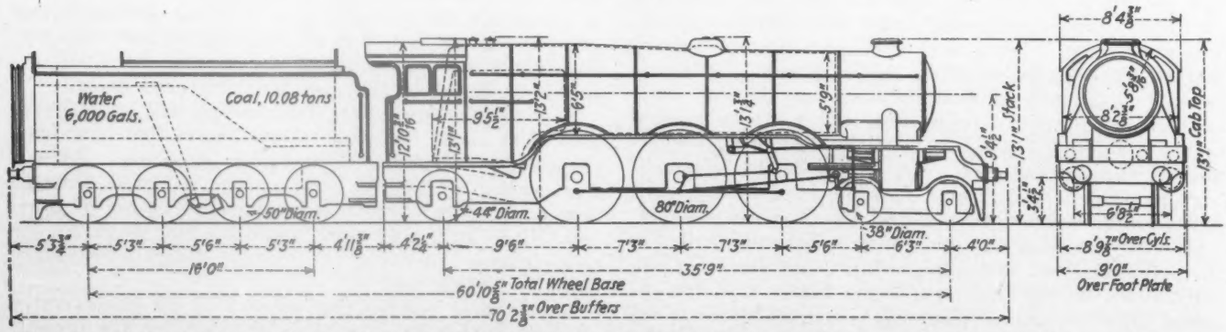
agreement and penalties imposed on 129 counts in the sum of $12,900. Three cases, involving 44 counts, were pending in the district courts at the end of the year ending June 30.

Amendments to the Rules for Inspection and Testing

The part of the commission's order dated February 21, 1929, promulgating Rule 118, applying to equipment of new locomotives with mechanically operated fire doors, together with the provision applicable to maintenance of fire doors became fully effective on April 1, 1929, and the part of the order applying to equipment of existing locomotives with mechanically operated fire doors when receiving classified repairs became fully effective on July 1, 1929. The terms of the order are being generally complied with. However some of the mechanically operated fire doors that were at first applied as a result of the order contained inherent defects that precluded proper operation; these are now being replaced by fire-doors that are apparently satisfactory.

No formal appeal by any carrier was taken from the decisions of any inspector during the year.

* * *



Elevation of the 4-6-2 type locomotives used by the London & North Eastern on its non-stop runs between London and Edinburgh—This drawing shows the tender before the corridor was installed

Cylinders, diameter and stroke, (3) 20 in. by 26 in. Weight on drivers, 134,000 lb. Steam pressure, 180 lb. Diameter of drivers, 80 in. Tractive force, 29,835 lb.

EDITORIALS

An "Outsider" Talks On Locomotive Design

The paper by Dr. C. F. Hirshfeld, chief of the research department, The Detroit Edison Company, on High-Pressure and High-Temperature Steam for Locomotives, which was presented at the annual meeting of the A. S. M. E., is an excellent example of the contributions possible from engineers employed in industries other than the railroad. His paper was prepared at the request of the Railroad Division—quoting Dr. Hirshfeld—"apparently in the belief that one familiar with modern developments in stationary-steam practice might be able to bring you useful thoughts and experiences from that field."

Dr. Hirshfeld disclaimed any special knowledge of locomotive practice, but offered his suggestions subject to further check and analysis by engineers expert in locomotive design. In other words, he presented his ideas to the specialist in steam-locomotive practice for what they were worth.

There is no doubt but that the designer of steam locomotives, like the designer of power plants for marine service, can profit from recent developments in the steam-power-plant field. The consideration of ideas and experiences from engineering fields closely allied to the railroad should go a long way toward improved perspective and lead to further progress.

Associations And Conventions

A definite movement has been developed by the American Railway Association to cause various associations of mechanical department officers and supervisors to cancel arrangements for conventions during 1931, and it has been announced that a committee of the Mechanical Division of the American Railway Association will meet with presidents and secretaries of all of the railroad associations to consider possible consolidations of the railroad conventions of the present independent associations. This brings a serious problem before the executives of these associations. On their action, as well as that of the Mechanical Division committee, depends the future welfare of the various organizations and, what is of even greater importance, the future welfare of the railroads in the various specialized fields with which the associations deal.

The attention which the holding of nine conventions during the year has attracted to the associations which deal directly or indirectly with some phase of mechanical-department operation has subjected them to considerable criticism. Most of these associations have the benefit of exhibits of equipment for use in shops or on locomotives and cars, the assembling of which, in the aggregate, involves a very considerable expenditure. These exhibits have grown up as an auxiliary of conventions of the railroad associations and the exhibitors have contributed extensively to the entertainment which forms a part of the convention programs. Whether or not the expense of holding these exhibits is justified is primarily a matter to be settled by the manufacturers of supplies and equipment who exhibit their products. In practically all cases the exhibits have developed to their present status because these manufacturers believed that the opportunity offered by a convention to reach in one place and at one time a large number of railroad men, who in one way or another influence the purchase of their equipment by the railroads, offered them an opportunity to do a job of sales promotion and educational work which could not be done as well or as cheaply in any other way.

If conditions have changed or the character of some of these associations has become such that the exhibits no longer offer such opportunities, the obvious recourse of these companies is to discontinue exhibiting. Should it be impossible for an association to hold its annual conventions were the exhibit to be discontinued, it certainly raises a serious question as to the continued usefulness of that association.

What has just been said is of general application irrespective of business conditions. Now, however, the railroads are faced with the necessity for extensive curtailments of expenses, and it is this situation which has led the American Railway Association to request the mechanical associations to discontinue the holding of their conventions, at least during the coming year, in the interest of economy.

This raises another question. Should any association have something to contribute to improvements in the effectiveness or economy of operations within the field of its activity, is it true economy to withhold meeting for the consideration of such problems at the present time? If an association does not believe that it has anything to offer which is of value to the railroads during the present situation, does it not raise a question as to the value of the association at any time?

Obviously the advisability of holding a convention at the present time, accompanied by an extensive entertainment program, is questionable, but one good test of the usefulness of an association may well be its ability to hold a productive business meeting devoid of all entertainment features.

These are questions to which the executives of the various associations must give careful consideration.

Material Delivery in Car-Repair Yards

One of the most important features of any rip track or car repair yard is the method of delivering material from the store-room or shop departments to cars which have been spotted on the various tracks for minor or extensive repairs. Obviously, no single system, however carefully and efficiently devised, can meet the needs at every car repair point. At small points where relatively few cars are undergoing repairs at any time, doubtless an expenditure for anything more than a well-maintained dirt or cinder roadway with a power-operated tractor and a limited number of trailers would not be justified. At larger repair points, however, the volume of material to be handled daily may well justify substantial investments in delivery systems. Labor is such an important element in car repair costs that every

reasonable effort must be made to conserve it at both large and small repair yards by handling material efficiently and promptly to the cars, thus saving man-hours of labor cost and, in addition, permitting the more prompt return of the cars to revenue service.

In climates subject to heavy rain and snowfall, it often becomes practically impossible to maintain ordinary roadways in condition for the satisfactory operation of truck and tractor equipment, and, frequently, this equipment is hardly able to move itself, to say nothing of dragging one or more low-wheel trailers loaded with car wheels or other heavy material. How can this problem be met?

The first solution to suggest itself would be the installation of concrete roadways, which would give a hard surface but still leave unsolved the problem of snow disposition. Moreover, car repair yards usually cover a large amount of territory and, in most cases, railroads have not felt justified in going to the expense of installing concrete roadways. As an intermediate measure, a great many yards have been equipped with narrow or standard-gage material delivery tracks between alternate tracks devoted to the repair of standard-gage equipment. Push cars of various types are generally used for the movement of material over these delivery tracks, small turntables being provided at the crossings, wherever necessary to get from one track to another. Heavy loads of lumber, wheels or other material can thus be moved readily from one point in the car-repair yard to another without danger of getting stalled in the soft ground or blocked with snow, which can be cleaned from tracks much easier than from the ordinary roadway.

The difficulty with this method is the inefficiency of employing manual labor to push cars of material about the yard, accompanied by much loss of time and delay to repair operations. The push car, when loaded with heavy material, requires the efforts of not less than three or four men to move it along the tracks and, often, a "slow motion" camera would be required to record accurately the progress of the car. As long as the car is moving, the foreman or supervisor has little recourse but to fume inwardly, for any objections he may advance are likely to be countered with the familiar expression: "We are not horses; we are going as fast as we can." And, is there not a substantial degree of merit in that contention? Everyone familiar with car-repair operations can readily bring to mind a picture of a loaded push car proceeding leisurely down the track under the efforts of a number of men who, regardless of whether they are exerting their best efforts or not, are wasting both man-hours and car-hours. It is a logical question to ask how long railroads can afford to carry on such a wasteful practice and, in this day and and age, permit men to do work better accomplished by horses or power vehicles.

The challenge of this particular railroad problem has been taken up by the Chicago & North Western and a solution proposed, as described on another page of this issue, namely, to motorize the narrow-gage material-delivery system. Experience over a period of nearly two years at three car-repair points has apparently fully demonstrated the economies anticipated from the replacement of manual labor by mechanical power for handling material. After considerable experimenting, a gasoline power-unit, operating on flanged wheels with chain drive to the rear wheels and having a four-wheel type front swivel truck, was developed. It is equipped with a carrier on the rear and can be used without trailers for the delivery of a large proportion of the small material required in repairing cars. Special trailers are, of course, provided for the handling of heavy materials such as wheels, lumber, etc. The only change necessary in the narrow-gage rail system formerly used was the installation of curves and switches in place of the turntables. One man operates the power unit, throws the light switches and handles as many as eight trailers loaded with wheels, as compared with four men formerly required for handling a single wheel trailer. In the handling of scrap trailers in a train up the inclined way provided to the scrap dock, the power unit is also as far superior to man-power that there can be no real comparison.

The motorized narrow-gage track and equipment constitute in effect a miniature transportation system superimposed on the repair yard and, with the careful and studied arrangement of tracks, gives ready access to any car in the yard. Movement of the equipment on rails instead of rough roads contributes to low operating and maintenance costs and, considering all elements of expense, including the cost of alterations in the narrow-gage track system and an ample allowance for depreciation, the North Western reports that the motorized narrow-gage material delivery system will pay for itself in a few months' operation.

Seven Years Hard Work

One of the disguised blessings of the periodical and temporary slowing down of business is the fact that circumstances force upon many people the necessity of doing some pretty solid thinking about the future. The thinkers may generally be divided into two broad classes —one that thinks that conditions such as we are experiencing are the inevitable portion of mankind and that nothing very much can be done about it except to suffer through it, and the other more constructive class that knows there is something lacking in this scheme of industry and business and is striving to find the sane and sound solution to the problems that are before them. The latter class is much too busy now to be bothered very much by hard times.

As this issue goes to press we are not only facing a new year but we are facing a new period in the business cycle—possibly even a new era in railroading. It is possible that the thousands of men in the mechanical departments of American railroads do not realize that conditions are going to turn the spotlight on them during the next few years.

It is to the mechanical department that railroad managements are going to look to discover the possibilities for greater economies in locomotive and train operation, still greater savings in car and locomotive maintenance and the wider application of sound economic principles to the management and organization of shop and engine terminal. The next few years will impose on mechanical department officers and supervisors the responsibility of spending wisely many millions of dollars, not to increase the productive capacity of railroad plants, but to effect economies in equipment maintenance.

Someone once said that "Worry is thinking without facts" and if this is true there are going to be many problems in the next few years of mechanical department operation that will cause some people a lot of worry. One of the elements that at times seems to be lacking in railroad operation is an agency which would permit the reduction of all problems to basic facts upon which could be developed a proper course of action. Mechanical-department men will be expected to find designs of locomotives that will permit more economical operation on the road at less expense for fuel and maintenance; new designs of cars that will more nearly meet

the demands exacted by changing methods of shipping and at the same time meet squarely the problem of repair shop operation so as to be in a position to know where money may be expended most effectively to reduce the locomotive-mile and car-mile cost of maintenance. Experience alone will not solve these problems and because the railroad as an industry is somewhat different from all other industries, very little help may be expected from outside sources. The only salvation seems to be to get the facts concerning the many problems and to apply these facts to the practices of the past. It may be surprising how many practices will require radical changing.

Up to a few months ago two absorbing problems were gradually forcing themselves to the front—stabilization of employment and personnel relations. The need for the solution of these two problems is probably better appreciated now than it could have been a year ago. Now is the time to look at these questions in the light of past experience, gather volumes of new facts concerning them and decide the course to take to assure the railroad industry a place as a leader in the stabilization of the business of the future.

We have had our "seven lean years" in the past twelve months and to that class of railroad mechanical men who can still view the future with confidence there appears the prospect of seven years of hard work the rewards for which will be to place the railroad industry in a position where it will be respected for the fighting, thinking industry that it should be and individually to raise the railroad man's estimation of himself and his job to a point where he will feel that he need offer no apology to any one for being a railroader. How to accomplish this is the problem. May we offer a paraphrase of the epigram "Get the facts and you won't have to worry."

The Unemployment Problem

Like the majority of other industries, the railroads are in the midst of a period of acute unemployment the basic causes of which are beyond their own control. Economists tell us that the causes lie in mal-adjustments somewhere in the chain of economic processes between the production of goods and their ultimate consumption and that, basically, these mal-adjustments arise from the mass effect of the complex and uncontrollable impulses of human nature. The solution, they say, lies in co-operation—co-operation not alone of the units in a single industry nor of all of the industries of a single country, but co-operation which is world wide in its scope and political as well as economic in character.

To those who are responsible for the management of individual units of industry, bringing about co-operation on any such gigantic scale will appear to be attended by insurmountable difficulties. So far as the immediate needs of each industry are concerned, there is no solution of the problem at all on this basis.

During the past few years many industrial corporations have undertaken the development of policies and programs for the purpose of eliminating periods of seasonal unemployment. These measures the economists, from their high vantage point of detached observation, are inclined to brand as mere palliatives—remedies which treat the minor symptoms but which do nothing to remove the causes of cyclical periods of industrial inactivity. Recognizing the vagaries of human nature, particularly as they are disclosed in buying habits, the economists are, perhaps, not to be blamed for their lack of enthusiasm for the measures which individual industries have had the temerity to develop.

The managers of industry, however, have had much experience in dealing with human problems in production and they are not so readily convinced of the hopelessness of improving the regularity of employment by the administration of their palliatives. Their experience in dealing with human nature in their employee relations has led them to believe that, while it may not be possible to effect a forced control of human impulses, measures of wise leadership may be confidently counted on to meet with a high degree of co-operation from the employees.

The railroads are a striking exemplification of the need for a wide-spread inter-industrial co-operation for anything like a complete solution of the cyclical periods of unemployment. Transportation, being a service, cannot be produced and stocked in advance of immediate requirements, and, hence, the railroads are more helpless than the producing industries, so far as their major activities are concerned, in a period of general depression like the present. But they have been no slower than other industries in attempting to stabilize employment, so far as the conditions within their own control would permit.

During recent years many roads have given serious thought to smoothing out seasonal variations in employment in their shops, and a variety of measures have been adopted to that end. During the past few weeks there have been several examples of serious efforts to ameliorate the even more difficult situation caused by the general depression. Some of the emergency measures, it is true, have been at the expense of employment in other industries. In other cases, however, by securing permission from the Interstate Commerce Commission to charge to a suspense account considerable amounts expended for maintenance of equipment not required by current use of the equipment, to be taken into the proper operating-expense accounts during a later year as the equipment is returned to service, roads have been able to provide immediate employment for many men who otherwise could not have been employed until 1931 without unduly affecting the operating ratio for 1930. While in the long run the number of man-hours of employment cannot be increased in this way, they can be so smoothed out that the hardships imposed upon the employes by the depression will be minimized. To that extent these measures are a real contribution to restoration of more nearly normal business conditions.

Let it be admitted that these measures are palliatives so far as their direct effect in preventing the recurrence of cyclical periods of unemployment is concerned. But let no one for that reason be deterred from adopting similar measures. It is only through the courage with which the managers of individual industrial and business organizations attack those phases of irregular employment which are within their own control that a beginning can be made toward any kind of co-operation which reaches beyond a single industrial organization.

As each industry learns from experience the limitations of its own unaided efforts to improve its own condition, is it too much to hope that it will become increasingly conscious of its measure of responsibility, as a consumer of their products, for the conditions of employment in other industries? May it not thus be impelled to shape its activities as a purchaser so that other industries may be aided in their efforts to solve their own problems? Is this not the first step in the evolution of that wider measure of co-operation which in itself now seems impossible of attainment?

THE READER'S PAGE

New Wheels and Oversize Wheel Seats

To the Editor:

In his article on page 639 of the November issue, W. H. Shiver discusses the use of an axle with an oversized wheel seat. I believe that most of us consider an axle with an oversized wheel seat a very valuable find, for we usually have enough slightly oversized wheel seats in our stock of second-hand cast, cast-steel and wrought-steel wheels to welcome such an axle, to keep from buying new axles to dispose of these wheels.

I should like to ask why anyone would use an axle with an oversized wheel seat for new wheels when the A. R. A. rules permit a variable dimension of from 6¾ in. to 7 in. on new wheels and also on the use of wrought-steel wheels of 60,000 lb. and 80,000 lb. capacity bored to larger size. Why bore them to fit an oversized wheel seat when the same variable dimensions of from 6¾ in. to 7 in. may be used, thus saving a waste of metal from the core, and axles with wheel seats of these sizes can always be secured from stock?

A. F. Tarpley.

Loose Wheels—A Reply

New Haven, Conn.

To the Editor:

In reply to "A Reader's" letter to the editor which appeared in the August issue in which he asked the question, "Does a wheel have to move on the axle after it has been removed from under the car as proof that the wheel is loose, or is there a possibility of it being sufficiently tight on the axle to deceive the car repairman?"

A loose wheel is a rare defect. However, wheels with indications of looseness are quite common, and oil seepage is the most common indication found. In some cases steel dust will show up when the wheel is decidedly loose.

A. R. A. Rule 81 states that the owners are responsible for wheels removed account of being loose. The same responsibility applies to wheels removed from service on account of indications of the wheel being loose, such as oil seepage from the inside of the wheel fit. There are many wheels removed from service on account of oil seepage. But frequently, when these wheels are placed on the press, they will show proper pressure in the fit. This condition, however, should not prevent car inspectors from removing wheels from service when oil seepage is visible, as this is the only indication that can be used to remove these potential hazards from service.

Oil seepage is a defect that can be eliminated if the wheel is not actually loose. Wheel shops are usually to blame for this condition. A poor mixture of coating for the wheel seats, an improper bore, a bore with ridges or chatter marks, which may be made when removing the boring bar. A longitudinal seam in the wheel seat might allow the oil to seep through and give false indications of being loose.

The most common practice in a wheel shop which will cause oil seepage is to make an improper coating mixture. The A.R.A. Committee on wheels recommends a white-lead mixture with boiled linseed oil, 12½ lb. of lead to a gallon of oil, thoroughly mixed. Most wheel shops adhere to this practice but use a lubricating oil or raw linseed to thin the coating down after it has been used for a day or so subsequent to the time of mixture. The lubricating oil will not dry and will show as oil seepage as it has a tendency to work out from the fit after the wheel has been in service. The most common practice used to determine a loose wheel is to chalk the axle at the wheel seat and inside of the wheel plate and roll the wheel up against another pair of wheels. The shock will have a tendency to move the loose wheel around the axle. If the wheel moves it will break the chalk line.

A good practice followed by some wheel shops is to place a mark in white lead on the axle and inside the wheel plate. This mark, of course, is not visible after the wheel has been in service for a considerable length of time, but if any improper condition should exist to allow oil seepage, the fact that the mark does not coincide at the fit will show whether or not the wheel is loose on the axle. This is one of the best methods used for quick inspection of wheels for looseness. If this practice or some similar standard practice were used it would eliminate the unnecessary removal of many wheels because of oil seepage. Until some method is developed to give car inspectors some accurate method to determine whether or not wheels are loose the wheels should be removed when any indications are shown.

J. W. McDonnell.

Make Foreman's Jobs Attractive

To the Editor:

The October issue of the *Railway Mechanical Engineer* runs an editorial on "The Foreman's Wages," of which I wish to express my sincere appreciation. I have wondered in times past why some one did not foster an improvement in conditions particularly affecting the enginehouse foreman. Although not employed at an enginehouse or in a supervisory position of any kind on the railroads, I have come in contact with many of the minor supervisors and find that in the great majority of cases they are skilled in their line, fully capable of their duties and, generally speaking, working for much less per hour than many of the men under them, when one stops to consider the long tour of duty and the fact that they are subject to call at practically any hour of the day or night.

I am particularly acquainted with one of the larger railroad's practice in fostering the special apprentice course, the graduates of which usually fall heir to an enginehouse job for at least a couple of years of their training. I believe that a certain amount of enginehouse work is essential to their advancement but nothing can destroy a sense of advancement as rapidly as to hold down a gang leader's job in an enginehouse for an indefinite period.

These special apprentices, usually college graduates,

aline themselves with the railroad with the thought and hope of an official position. They start in at a rate much less than paid to many college graduates in other industries and struggle along on rather meager wages for a three-year period to wind up their apprenticeship as inspectors, or enginehouse gang leaders, etc. Surely it is not the intention of the railroads to lose the training that they have worked so hard to give these young men, but with the field of advancement so seemingly occupied by men with more seniority, etc., there seems to be but little opportunity for these men to advance. Therefore, they seek elsewhere for positions and I know that this particular railroad has lost a number of high type men who would have become splendid officers simply because the railroad would not, or could not, advance them and pay them wages somewhat on a par with those paid for the same ability and effort in other industries.

Your editorial on foreman's wages is timely indeed.

B. CHARLES.

A Reader Comments On Standard Cars

TO THE EDITOR:

I note with some interest that the editorial on page 635 of the November *Railway Mechanical Engineer*, with reference to the recent address made by T. C. Powell, president, Chicago & Eastern Illinois, before the Car Department Officers' Association convention at Detroit, Mich., infers that the traffic department and the shippers are primarily responsible for the condition to which Mr. Powell objects.

There is no good reason why shippers should not expect a container for their shipments which permits the economical loading of that shipment. Neither is there any reason why, with the large variety of commodities that can be loaded in a certain uniform size car, such cars should not be developed. The shippers would doubtless be glad to co-operate with the roads to this extent.

The railroads are in a poor position to make any complaint against the shippers' demand for various types of cars until their own engineers are able to agree on some uniform type of car construction.

The American Railroad Association has a Car Construction Sub-Committee which is in session more or less continuously and which is supposed to develop recommended standards for car construction. Apparently this committee gives more attention to the strictly engineering details of the problem than to the practical application of the finished product. Mr. Powell's address indicates that the railroads think but little of the committee's recommendations for standard cars inasmuch as the number of standard cars built decreased from 23 per cent of the total box cars in 1926 to about 2 per cent of the total box cars built in 1930.

The small number of standard cars actually built indicates that the individual railroads are unable profitably to use the so-called standard car and must develop their own type of car—a car which will meet the demands of that road's shippers.

Before placing the blame for use or demand of non-standard cars on the traffic department, can it be said that the Mechanical Division committee has made a survey of the car demand situation with a view to designing a standard car that will suit the majority of shippers? This does not seem to be the case. Apparently the committee designs a car which is suitable from an engineering and maintenance standpoint and lets it go at that. The surprising feature is that the officers of most of the railroads involved approve the recommended standards, knowing full well that they are unsuitable and that they would not consider the purchase of such a standard.

Why blame the traffic department for being unable to predict the type of car that will be demanded when they must contend with the requirements of many shippers who in turn have the experience of trying to make their lading conform to the area, design and cubical capacity of hundreds of different types of cars, many of which were designed quite a while before the shipper became so rigid in his demand for a particular type of car?

There will always be a demand for a certain number of odd-size cars for unusual lading but it certainly appears that, if the car designers pay more attention to the problems of the traffic department and less to the convenience of the car builder and maintainer, it will be possible to work out a standard car that will increase in demand as time passes rather than decrease in the manner that the so-called present standard car has, as indicated by the lowering percentage of standard cars being built.

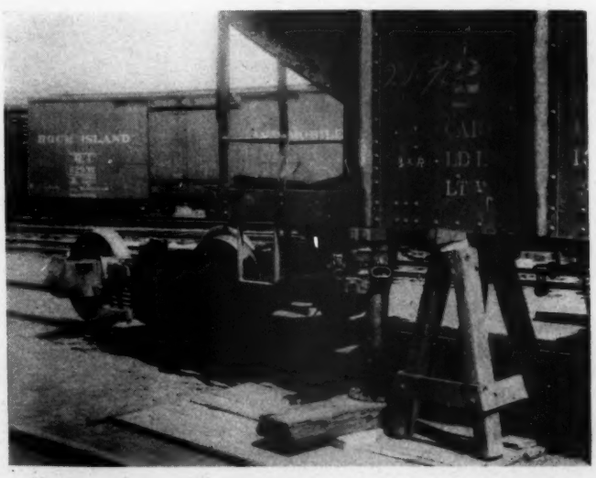
Traffic is the life-blood of the railroad and there should be no foundation for complaints on shippers' demands for economical containers when consideration is given to the fact that the railroads themselves have the answer to the problem in their own hands in that they could design a series of uniform containers or cars for the various groups of lading which would be economical both to the shipper and the railroad.

A wonderful opportunity has been overlooked in the past few years to complete the development of uniform equipment. The thousands of wooden cars, which were of many designs, were retired from service and could have been replaced with uniform equipment but unfortunately this was not done and the ancient method of each road following its own nose was continued with the result that the situation remains the same with the steel equipment as it was with the wood equipment.

It behooves the car designers to wake up and discover that, while the engineering is important, traffic and the satisfaction of the shipper is more important and that no type of car will ever be standard that is not designed to suit the shippers' convenience.

R. R. HOWARTH.

* * *



An illustration of safe practice in jacking and supporting a car body

With the

Car Foremen and Inspectors

Proviso Hump Yard Car-Repair Facilities

THE Chicago & North Western hump-yard repair tracks, located at Proviso, Ill., has a capacity of 110 cars, with a daily output under ordinary conditions of about 75 cars, employing a force of 40 men. This car repair yard located at the foot of the hump classification yard is operated for the purpose of making medium and light repairs to all loaded and empty bad-order cars received off the road from the Galena and Wisconsin Divisions. Cars are inspected at the receiving yard, and any cars found in bad order are switched over the hump and to a specially designated bad-order track. They are then spotted on the hump repair track. Heavy repair cars are switched to a separate repair yard of 500-car capacity, located adjacent to the forwarding yard.

The proximity of the medium and light repair yard to the Proviso Hump Yard permits rush loads of perishables or other commodities being immediately spotted, repaired and returned to the classification yard for forwarding without unnecessary delay. All loaded cars, and empty system and foreign bad orders are repaired on the same date spotted, the car-repair force being balanced to accomplish this result.

The buildings at the car-repair yard are constructed of tile, being fireproof throughout, and equipped with electric lights, washing facilities, modern conveniences, etc. These buildings occupy the center of the repair track area, making them readily accessible from all parts of the yard. They comprise the following units: Lumber shed, paint shop, steel car repairers' room, air-brake room, air-brake repairers' room, mess room, lavatory, car foremen's office, store-department office, blacksmith shop, oil house casting platform, wheel bed, elevated scrap dock and incinerator. The buildings were designed as a result of experience with two former repair yards, and the arrangement of all buildings and units have been found to fit the needs without change from the original layout.

The lumber shed is of special design required for the protection of a limited stock of lumber used in repairing freight cars. The steel-car repairers' room is equipped with tools and facilities for handling this phase of the work. In the air-brake room, triple valves are repaired and tested, angle cocks ground and similar work handled. The air-brake repairers' room is equipped with modern facilities for performing air-brake work.

Comfortable Quarters Provided for Car Men

A feature of the repair track is the provision of commodious, comfortable and well-lighted quarters for the car-repair forces. The mess room is equipped with benches and tables, lockers, a water fountain and lavatory and is kept clean and warm at all times.

The car foremen's office is located centrally with respect to the buildings in the repair yard, the stores department office being adjacent to it. The store-department building is divided into two sections, one containing the office and storage for small materials, and the other unheated section for rough castings.

A modern blacksmith shop, adequate for all operations commonly encountered in light repair work, is equipped with a power-driven drill, grinder and pneumatic hammer, in addition to the forge. Neatness is also a notable feature of this shop.

Motorized narrow-gage train delivering material at the North Western car repair yard, Proviso, Ill.

The packing renovating plant is completely arranged for the receipt and distribution of packing without the necessity of the journal-box packers going inside. The packing is received through an opening with a sliding door just over the receiving tank and is distributed as required through a chute to the packer wheelbarrow. Complete facilities in this house are provided for renovating packing and filtering oil.

An outdoor casting platform is provided for the storage of couplers and larger material not appreciably harmed by exposure to the weather. A wheel bed, with a capacity for 300 pairs of second-hand and new wheels is arranged as illustrated, the wheels being separated according to size and kind. Air cranes for loading and unloading these wheels are provided, as all wheels are received or shipped in gondolas or flat cars, double decked. This is a feature of North Western operation which contributes much to economy, all rip tracks and car repair points on the system being equipped for doubledeck loading.

The scrap dock, located on an elevated platform, is partitioned off for the different classes of castings and scrap, which greatly facilities the handling of material and loading of scrap on cars.

One of the most important features on the repair yard from the point of view of contributing to neatness and a generally picked-up condition is the incinerator, made of a scrap locomotive boiler mounted on a brick base and in which all refuse is disposed of by burning. A sheet metal door covers the firebox opening and serves for the admission of the scrap wood and material, at the same time controlling the draft. A screen in the top prevents the emission of any sparks large enough to cause a fire hazard.

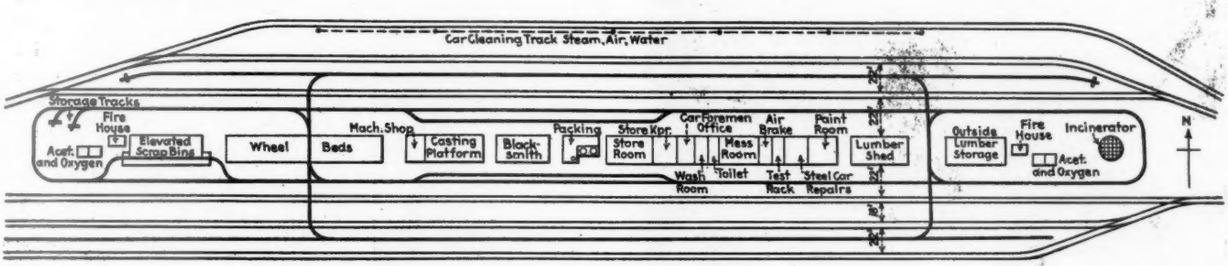
The influence of order and cleanliness is not only evident in the increased efficiency of the repair track but in the greater safety of operation. Work has been carried on at this point for the past eighteen months with only one reportable injury.

Adjacent to the hump yard is a freight-car cleaning track equipped with steam, air, water and drainage and having a capacity for cleaning 50 cars a day. The location of the cleaning track is particularly advantageous in the interests of prompt car movement, because certain repair work, such as renewing flooring, sheathing and minor operations can be performed on the cleaning track under protection, eliminating the necessity of extra switching. Cars are cleaned at this point for all kinds of commodities and commodity cards applied to indicate the loading for which each car is suited.

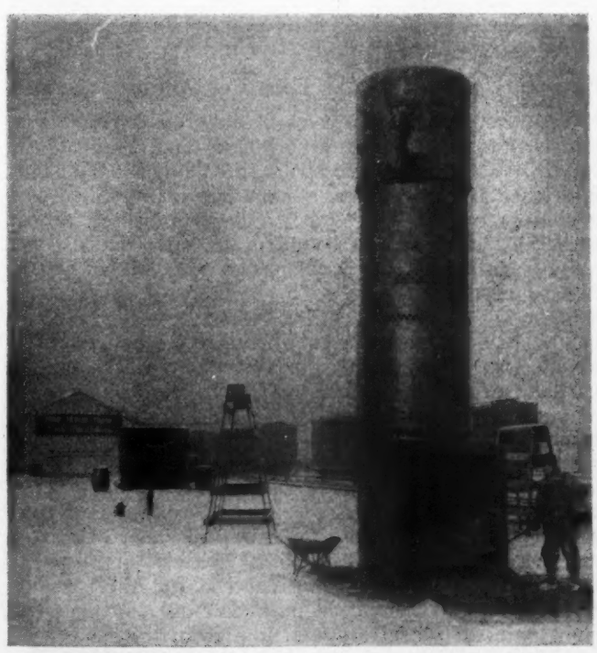
Motorized Narrow-Gage Material-Delivery System

One of the most novel and interesting features of the hump yard repair track is the motorized narrow-gage material-delivery system which has been in service long enough to demonstrate marked flexibility, economy and adaptability to this kind of work. Referring to the drawing, it will be noted that a track system of 24-in. gage permits delivering material to a car in any part of the yard. The main track of the system completely encircles the buildings, side tracks or turnout tracks making it possible to load heavy material from certain departments, such as the blacksmith shop, casting platform or storeroom, directly onto trailers. An outer belt track connects with the wheel bed, making possible the loading of wheels and their delivery to any point in the yard with little effort and no delay. Extensions of the narrow-gage system also reach to the elevated scrap platform at the west end of the plant and to the incinerator at the east end.

The power unit consists of a Model A. Ford, adapted by the North Western Motor Company, Eau Claire, Wis., to operate on flanged wheels with a front four-wheel swivel truck and power furnished by chain and sprocket drive to the rear wheels. A special chassis was designed with a driver's cross seat in front and a carrier in back for holding couplers, brake cylinders, triple valves, air hose and similar relatively light material which constitutes approximately 80 per cent of the delivery requirements of this rip track. The power unit, therefore, serves not only as a tractor for hauling trailers, but is, in itself, a material supply car which handles a large proportion of the material directly from the store-room or shop to the car. The power unit is sup-



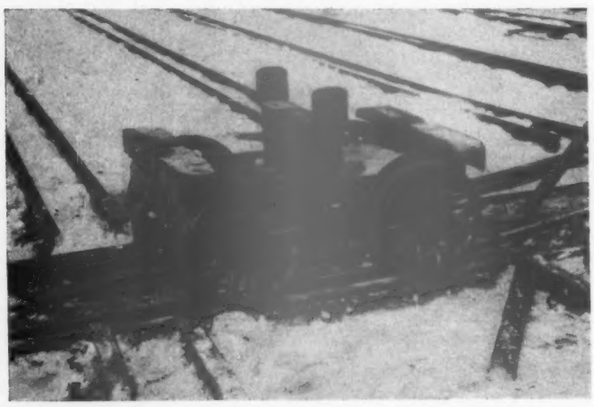
Arrangement of 24-in. narrow-gage track system used for delivering material at Proviso car-repair yard



Old locomotive boiler used as an incinerator

plied with a special brake equipment, as well as sand pipes for use under unfavorable rail conditions. Roller bearings are provided throughout and the unit is fitted with couplers which may be easily engaged.

Trailers for handling heavy material include in general only three types: A special trailer for handling wheels, a pair of wheel trailers with special bolster equipment for handling lumber, and a trailer car for handling scrap material and refuse. The wheel trailer is clearly shown in one of the illustrations and comprises a four-wheel unit with cross-bearers arranged at



Close-up view of the special car-wheel trailer with removable swivel bolster temporarily applied for handling long lumber

the proper height so that wheels can be rolled along the rail and up on the trailer with very little physical effort.

The special bolsters used on the car-wheel trailers for handling lumber are shown in another of the illustrations and can be readily designed to handle wider and higher loads of lumber, if necessary. The trailer car is in reality a triple combination car which has an ingenious arrangement of adjustable and removable side boards, facilitating its use as a box, low-side gondola or flat car. In practice, it is seldom found necessary to remove the sides entirely.

Savings Up To 250 Per Cent Per Annum Secured

The motorized narrow-gage material-delivery system is now installed at three points on the Chicago & North Western and experience has shown savings as high as 250 per cent on the moderate investment required in narrow-gage track and equipment. Where the tracks are already installed the only expense required in "permanent way" is for replacing the turntables, customarily used, by necessary curves and switches.

The principal advantage of this delivery system is that it gets material where it is needed, quickly and regardless of wind, weather, or ground conditions often making it practically impossible to operate truck and tractor equipment. Work and car delays chargeable to slow delivery of material are therefore largely avoided.

The most important single item of savings is the reduction in labor. Where three or four men were formerly required to roll a pair of wheels on a special trailer and push it from the wheel bed to the car, one man, operating the power unit, can take as many as eight pairs of wheels at one time from the wheel bed to any point in the repair yard in a fraction of the time formerly required. The possibilities of savings in time and cost of delivery of small materials, scrap, rubbish, etc, are also large. At one point, requiring the use of two power units it was found that necessary material could be delivered to the cars, scrap dock, incinerator, etc. with a saving of the labor of three carmen helpers and two laborers, or $5046 a year.

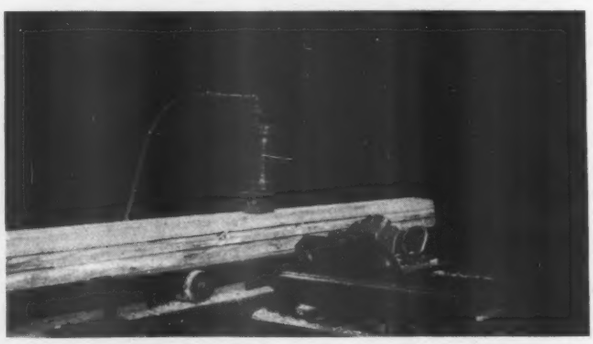
The operating expense for gasoline, oil, etc., is small, owing largely to the fact that heavy loads can be hauled on steel rails with relatively little tractive force as compared with movement over dirt or even concrete roads. The total operating expense, exclusive of labor, of the two cars mentioned, was only $310 for a period of one year.

Maintenance costs likewise are low and for a similar reason. With power equipment operating on rails, there is far less vibration, rough usage and actual abuse such as encountered when this equipment is used over dirt or cinder roads which are always relatively rough under the best of conditions and, when rendered soft by excessive rains or covered with snow, are often nearly impassible. The fact that maximum power of the motor is seldom required also contributes to long life of the equipment. Accurate records of all details of maintenance costs on the two power units already referred to show a total of only $125 a year.

The increased speed of operation, in addition to other advantages reduces the amount of power and trailer equipment required. At the Proviso hump repair yard, two power units are more than enough to take care of the requirements and the number of trailers in regular use is reduced 50 per cent. The aggregate saving from any material-delivery system is more or less proportional to the volume of material to be handled. Under the conditions at the hump repair yard, charging 6 per cent on the investment and the ultra conservative depreciation of 20 per cent, annual savings up to 250 per cent are being earned on the investment in narrow-gage track and material-handling equipment.

Gaining Out Freight-Car Flooring

THERE are many methods in use for gaining out freight car flooring to provide clearance between the flooring boards and the rivets on the center-sill cover plates, especially on gondola cars. While it is true



A pneumatic clamp holds two boards together while the gaining operation is performed

that this operation can be performed at the car at the time the flooring is being applied by using a sharp-edged tool or by providing the mechanic with an air motor, it

has been found more economical to have this work done prior to the time the flooring is delivered at the car.

A device for performing the work is shown in the illustration. It consists of a carriage on which two flooring boards are laid and clamped together with an air cylinder to prevent the boards from moving. An ordinary wood boring motor is mounted on an adjacent carriage, the point of the wood bit being directed between the two boards so as to form a half-circle hole in each board.

Not only is this device efficient but it eliminates the possibility of weakening the flooring boards by reason of too much material being cut out in the gaining operation and will assure the boards being gained out uniformly throughout the car and permit them to be nailed securely to the nailing sills.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Billing on Authority of Defect Cards

Northern Pacific car 5817 moved from the Chicago Great Western to the Great Northern through the Minnesota Transfer at the Twin Cities on October 2, 1928, at which time a defect card was issued against the C.G.W. which read as follows: "Two side planks removed (2 by 4 by 21 ft. 6 in. A. L.), 12⅝-in. by 3-in. bolts removed, two side planks removed (2 by 4 by 21 ft. by 6 in. B.R.), 12⅝-in. by 3-in. bolts removed. Planks removed for ventilation and placed inside the car. Labor only." The Northern Pacific repaired the car and billed the C.G.W. for both labor and material, stating that, when the car was returned home, the planks had been removed, making it necessary to furnish new material for repairs. It contended that the placing of the planks inside the car was done entirely at the risk of the carding road and that there is no authority under the interchange rules for marking the card "Labor Only".

The C.G.W. stated that the planks had been removed by stockmen for ventilation purposes during the movement of show stock and that when the car left its rails the side planks in question were inside the car. It contended that the case would not come under the fifth paragraph of Rule 32 since there was no evidence that the planks were damaged or mutilated in any way. For this reason, it further contended that the entire charge for labor or material was improper and that the defect card in question should be canceled. The C.G.W. stated, however, that if the defect in question is cardable the charge should be confined to labor only.

The decision rendered by the Arbitration Committee follows: "Removing parts of car as was done in this case and for the purpose stated, is a delivering company's defect within the intent of fifth paragraph of Rule 32. If defect card in question did not provide full protection, car should have been refused at the interchange point until protection was complete. The defect card as issued is, therefore, authority only for the labor charge."—*Case No. 1649—Northern Pacific vs. Chicago Great Western.*

Joint Evidence Final in Wrong Repairs Case

On September 4, 1928, the Skelly Oil Company tank car No. 1484, equipped with 80,000-lb. capacity trucks, was repaired by the Chicago, St. Paul, Minneapolis & Omaha at its Sioux City shop. Among the repairs made were four new 1⅛-in. by 16-in. box bolts applied at R-2 and L-2. Joint evidence was obtained by the car owner at Eldorado, Kan., on December 1, 1928, showing that two 1⅛-in. by 17-in. box bolts were standard equipment on the car at R-2 instead of the 1⅛-in. by 16-in. box bolts as applied by the repairing line. The repairing line stated that the 1⅛-in. by 16-in. box bolts were fitted with one unit nut of the combination holding and lock-nut type and contended that such repairs were equivalent to the 1⅛-in. by 17-in. box bolts fitted with two common holding nuts. The owner referred to that portion of the report on car construction contained in circular No. DV 640 dealing with 80,000-lb. capacity trucks. It pointed out that the report showed 17¼-in. and 17¾-in. box bolts equipped with common nuts and lock nuts as standard equipment on 80,000-lb. capacity trucks and that no provision was made for optional use of combination holding and locking nuts with 16-in. bolts when the car owner's standard is 17-in. bolts.

The decision as rendered by the committee is as follows: "The joint evidence is final. Claim of the Skelly Oil Company is sustained."—*Case No. 1647—Skelly Oil Company, vs. Chicago, St. Paul, Minneapolis and Omaha.*

Car Damaged in Switching

On March 25, 1929, Atlanta, Birmingham & Coast flat car No. 9011 was damaged in the East Thomas yards of the St. Louis-San Francisco. On March 26, the car owner, upon request, furnished the depreciated value of the car. On April 4, the Frisco advised the car owner that after a subsequent investigation it developed that the car had not been subjected to any unfair usage as defined in A. R. A. Rule 32, but had failed in fair service. As a result of this investigation, the Frisco requested disposition of the car under Rule 120. The car was dismantled on May 28, when disposition as required by Rule 120 was not furnished within 30 days, the Frisco contending that the matter was handled strictly in line with Interpretation 3 of A. R. A. Rule 120.

The A. B. & C. contended that the car was improperly handled in switching and that it was not subjected to fair usage. The owner further contended that the car was damaged in accordance with A. R. A. Rule 44 and maintained that the investigation of the incident by the Frisco did not show conclusively when or how the damage occurred. The owner also brought out the fact that the East St. Louis Junction car No. 5007 was damaged at the same time and contended that this indicated that its own car was unfairly used.

In rendering its decision, the Arbitration Committee stated that "The evidence is not conclusive that car was

subjected to any of the unfair conditions of Rule 32. Car owner did not within the time limit furnish disposition of this car under the requirements of Rule 120. Owner is responsible. The decision in this case has no bearing on the question of responsibility for damage to E. S. L. J. car 5007."—*Case No. 1648—St. Louis-San Francisco vs. Atlanta, Birmingham and Coast.*

Classification of Cars

On July 11, 1929 the Mobile & Ohio notified the Nashville, Chattanooga & St. Louis that the N.C. & St. L. car 32862 was destroyed in switch movement. The M. & O. requested the N.C. & St. L. to furnish a statement covering the depreciated value of the car. This statement was furnished by the N.C. & St. L. It showed that the car was a 60,000-lb. capacity all-wood gondola, class E4 and built or rebuilt on April 12, 1899, and that the depreciated value of the car was placed at $237.40.

The M. & O. admitted responsibility for the damage to the car but, contended that it was a class F car instead of a class E4 car. The M. & O. based its contention on the fact that the car was originally built some time during 1880 and was still equipped with wooden body bolsters, wood truck bolsters, wood spring planks and a built-up draft arm which had no direct connection whatever with the body bolster. The M. & O. pointed out the fact that it wished to establish a criterion, definitely settling the classification of these cars in order to avoid future controversy, since the N.C. & St. L. had 457 cars of the same series.

The N.C. & St. L. furnished prints showing that the draft arms were secured vertically by five ⅞-in. by 11½-in. bolts and laterally by nine ¾-in. by 6½-in. bolts. It pointed out the fact that the draft arms extended more than 24 in. beyond the center line of the body bolster and contended that the body bolster was of sufficient strength to transmit buffing and pulling shocks to all longitudinal sills.

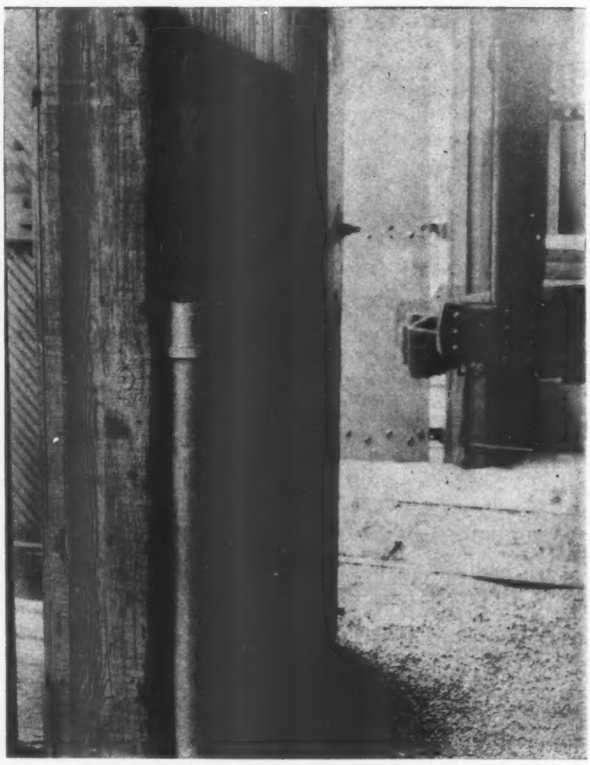
The following is the decision of the Arbitration Committee: "The car in question properly comes under class F and should be settled for accordingly."—*Case No. 1650—Mobile & Ohio vs. Nashville, Chattanooga & St. Louis.*

Closing the Car Shop Doors

IT has been said that there are more ingenious devices used in and about a car repair shop than anywhere else on a railroad. If a carman elects to make a pneumatic punch or press he merely hunts up a brake cylinder and in no time at all he has a device with all of the ear-marks of a machine. If he wants to make a delivery wagon he usually takes possession of a section foreman's push truck, burns the flanges off the wheels, shortens up an axle and a wagon comes into being (provided of course that the section foreman does not catch him in the act or the job has not progressed too far to save the push truck).

If there is a door to which some self-closing arrangement has been installed invariably it will be found that a brake chain sheeve wheel has been suspended from the hinged side of the door jam. A section of hand brake chain attached to the top of the door, descending through the sheeve wheel and to which is attached a couple of truck springs, a coupler knuckle or four or five follower plates and perhaps a few knuckle pins serve to provide the weight required to keep the door closed automatically.

The illustration, while still adhering to the brake



A scrap superheater flue furnishes the guard for the door-closing weights

chain and sheeve wheel shows the added feature of a section of superheater unit through which the weights are carried. The story is told that the addition of the superheater unit was brought about by a coupler knuckle, which was wired to the end of the chain, dropping off and painfully injuring the foot of a carman. Again a carman's ingenuity was responsible for bringing the door closing operation up to a higher degree of efficiency, a safety hazard being eliminated.

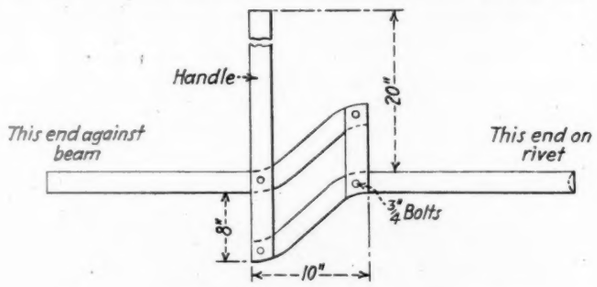
Bucking Bar For Rivets

IN the illustration is shown a bucking bar designed as a pantograph in order to be more effective in cinching rivets tightly and in speeding up production riveting. The bar gives the operator a leverage which is not obtainable in a straight type of bucking bar. It prevents vibration and enables the operator to keep the bar in line with the rivet.

The bar illustrated is made of 2-in. round steel, the ends being of any desirable length necessary for the particular conditions surrounding the work which is to be performed. As shown, it is designed to buck ⅝-in.

rivets, the dimensions of the pantograph being correct for the 2 in. bar. A bar of this style can be used effectively on construction and repair work by placing the back end against a beam or block and the other end over the head of the rivet, manipulation being affected by operating the handle. The pressure which can be exerted with the handle by the operator is sufficient to hold a rivet securely while it is being driven. It has been found to be exceptionally well adapted to the bucking of rivets in steel cars, as well as in boilers and locomotive tenders.

The bar as shown allows for a considerable amount of variation in the distance from the rivet to the support. If it is desirable to extend the end of the bar in order to reach a support, a 2 in. pipe of the necessary length can be placed over the end. The pipe should be plugged to within 6 in. of the end in order to allow it to slip over the end of the bucking bar that distance.



Pantograph bucking bar for production riveting

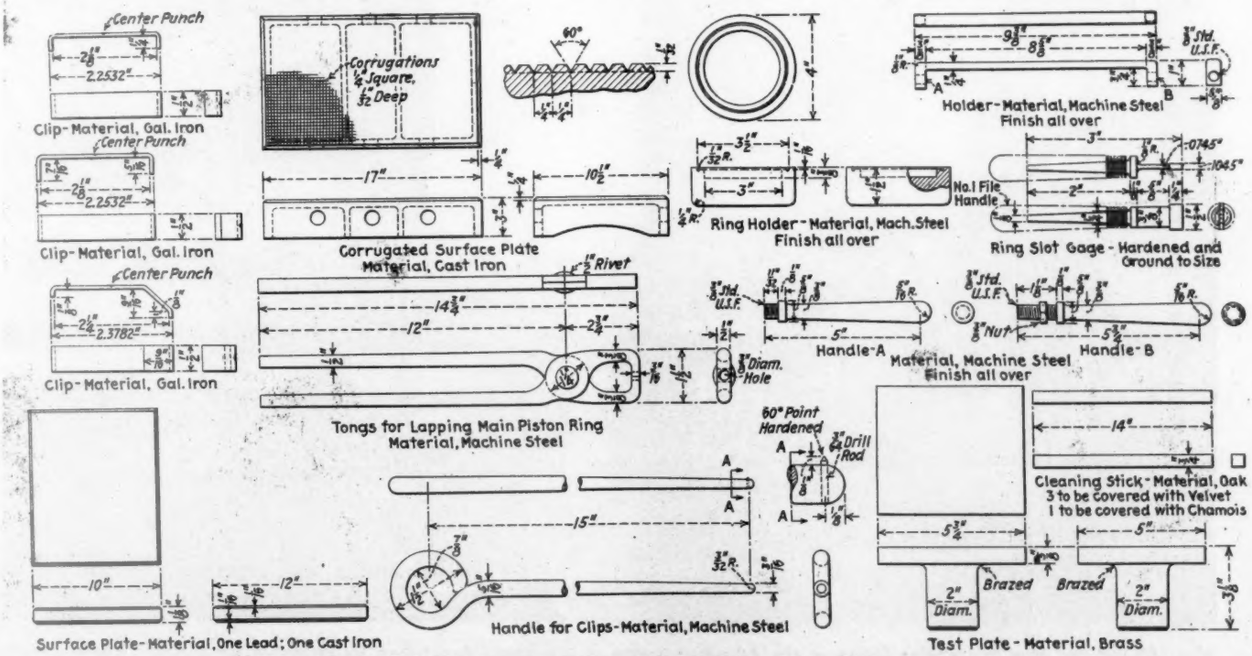
Tools for Repairing Triple Valves

THE tools shown in the drawing have been developed by the air-brake department of an eastern road to expedite the making of repairs to triple valves. Time studies made on jobs where these tools are used in conjunction with a repair stand and standard test rack allow 2 min. 22 sec. for removing the graduating stem nut, cylinder cap, and graduating spring and stem, clean and replace the graduating stem and spring, and to remove the piston; 2 min. 55 sec. to remove the emergency portion; 2 min. 51 sec. to replace the emergency valve, rubber seat and test; 2 min. 3 sec. to remove the exhaust plug, clean the bushings and blow out the valve body; 1 min. 2 sec. to remove the slide and graduating valves from the piston; 5 min. 43 sec. to clean the slide valve and seat, and graduating valves and 2 min. to true the cylinder bushings and gage the piston ring groove. Fifteen seconds are allowed to adjust the ring, and 2 min. 30 sec. for fitting the ring to the piston groove. The time required to assemble the slide and graduating valve to the piston, lubricate and apply, is 1 min. 56 sec. The cylinder cap is applied in 2 min. 10 sec.; grinding the check valve and blowing out the check valve case, 2 min. 27 sec.; assembling the emergency portion, 4 min. 2 sec.; tightening the graduating stem nut, applying the exhaust plug, removing the triple valve from the stand, stenciling and applying, and releasing the retarding device, 1 min. 35 sec. The complete job of repairing and testing triple valves can be handled in the air brake department of this road in about 34 min. A description of the triple valve repair stand referred to will appear in a later issue.

The test plate, surface plate, and corrugated surface plate, are finished all over. The lead surface plate is used to true slide valves and the cast-iron plate is used to lap rings.

The lead plate is loaded with No. 120 Aloxite or No. 120 carborundum grit which is worked well into the lead with a brass plate. A brass plate is used to true the face of the lead plate when necessary.

The cast-iron plate is used to lap rings. A piece of No. 80 Aloxite or carborundum cloth is glued to each surface of the plate with McCormick's glue or water glass. This is done by applying a thin coat of glue to the cloth and over the surface of the plate. The cloth is then spread over the plate and placed between two

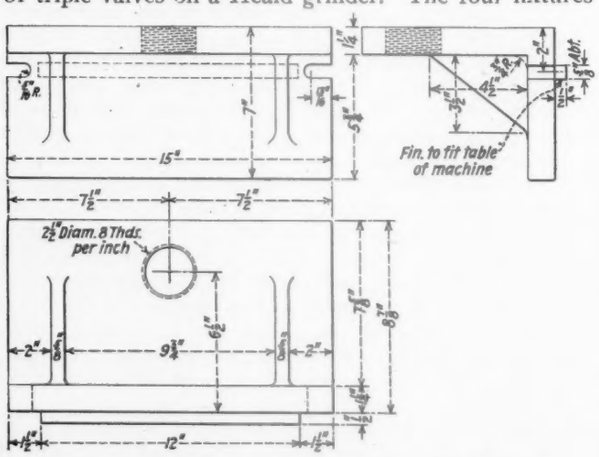

Center Punch
Clip - Material, Gal. Iron
Corrugations ¼" Square, 1/32" Deep
60°
Holder - Material, Machine Steel Finish all over
Corrugated Surface Plate Material, Cast Iron
Ring Holder - Material, Mach. Steel Finish all over
No. 1 File Handle
Ring Slot Gage - Hardened and Ground to Size
1" Rivet
Handle-A
Handle-B
Material, Machine Steel Finish all over
Tongs for Lapping Main Piston Ring Material, Machine Steel
60° Point Hardened
Drill Rod
Cleaning Stick - Material, Oak 3 to be covered with Velvet 1 to be covered with Chamois
Brazed
Surface Plate - Material, One Lead; One Cast Iron
Handle for Clips - Material, Machine Steel
Test Plate - Material, Brass

Tools which expedite the making of repairs to triple valves

boards. The boards are pressed together by clamps or weights placed on the top board while the glue is setting. The lapping plate is then allowed to dry over night. It should be kept in a box provided with a cover when not in use.

Grinding Air-Brake Parts

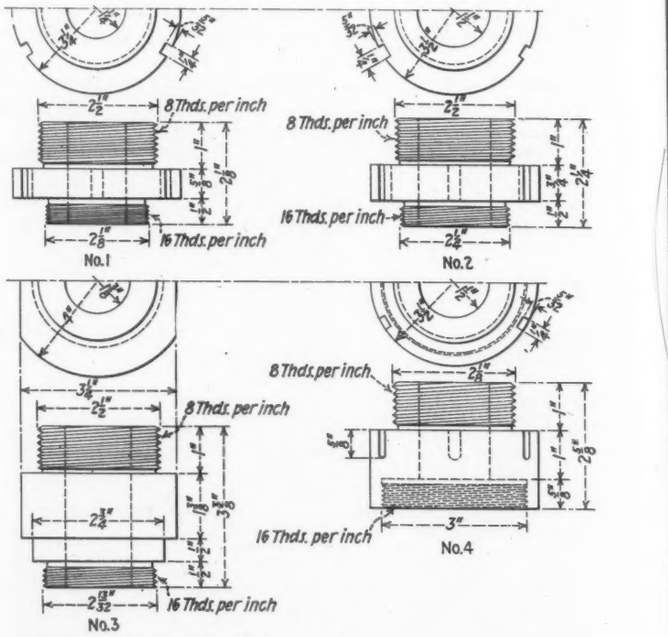
SHOWN in the two drawings are four fixtures and an angle plate which have been especially designed for grinding the gasket fits and other finished surfaces of triple valves on a Heald grinder. The four fixtures



Angle plate in which the fixtures for grinding triple valves are secured

are made of machine steel with notches around the circumference to take a spanner wrench. These fixtures are screwed into the 2½-in. hole in the center of the vertical leg of the angle plate which is made of cast iron.

Referring to the drawing showing the four fixtures;



Fixtures for grinding triple valves on a Heald grinder

the first fixture is used for F-25 triple valves, the second fixture is for F-46 triple valves and the third fixture for K-2 type triple valves. The fourth fixture can be used for F-29, F-27, K-1, F-36, H-49, F-1-NY, and H-1-NY triple valves.

* * *

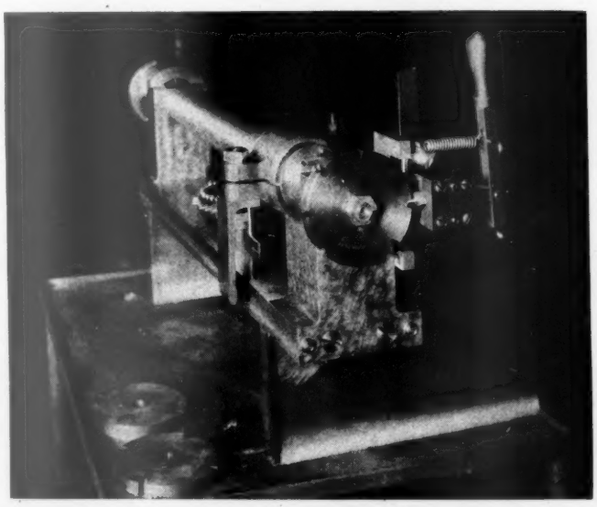
The old and the new in transfer tables at the Islington shops of the South Australian Railways—Cars similar to one shown in inset are now entirely replaced by modern 30, 40 and 50 ton cars

In the

Back Shop and Enginehouse

Graduating Special Rules and Gages

THE demand for graduating gages and other tools required in the several departments of a railroad shop for the maintenance of equipment and tools has brought about no little study, and after going carefully into the subject, the graduating machine*, operated by hand power, was developed at the Roanoke (Va.) shops of the Norfolk & Western. The machine



Another view of the graduating machine showing the construction from the dividing disc end

has been perfected and improved with a view of securing as near 100 per cent efficiency as possible. The accompanying illustrations will give the reader a good idea of its construction.

This machine is built on a steel plate, 1⅜ in. thick by 11½ in. wide by 18½ in. long, and is supported by two steel parallels, 5 in. high. It has a bearing bracket on either side, 1½ in. thick and 4⅛ in. from the top of the plate to the center of the bearing. These brackets carry the lead screw, which is 2 in. in diameter and has four-pitch Acme threads.

The screw is carried in two hardened and ground split tool-steel bushings. The right-hand bearing has a ball thrust bearing on both sides of the bracket, and the end of the lead screw has a fine thread, with a lock nut, so as to eliminate any end play. Over this is a housing, marked with a zero, for the graduated ring, which is carried on the hand wheel, and reads in thousandths of an inch. On the left end is the dividing disc, of which there are three; one with two notches, used for graduating in one-eighths, one with four notches, for graduating in sixteenths, and one with eight notches, used for graduating in thirty-seconds.

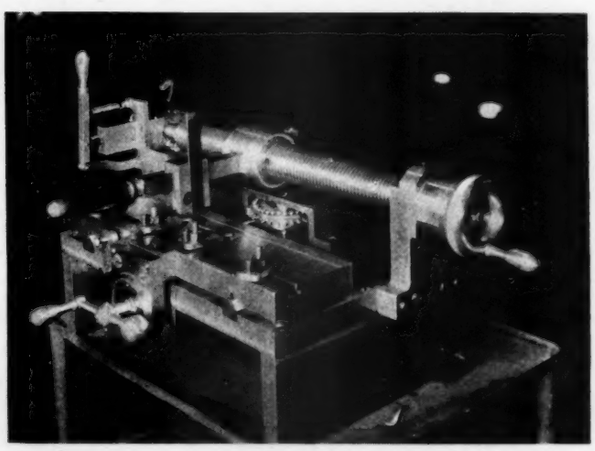
The discs are made of tool steel, hardened and ground, ½ in. thick by 4 in. in diameter. The notches are 5/16 in. wide and have a 14-deg. included angle.

The latch is made of tool steel, hardened and ground, and is ⅝ in. square in the bearing in which it is held cornerwise, so as to make it easy to take up for wear.

The lever for withdrawing the latch is made up of ½ in. square cold-rolled steel, 8 in. long, 3 in. at the top being turned down to receive the handle. A coil spring attached to the frame, and to the handle, holds the latch in the disc notch, locking the screw at its proper position, thus insuring perfect graduation.

The lever that carries the master nuts and the cutting tool is a steel forging, bored out and threaded, 2¾ in. in diameter, 24 threads per in., and sawed through at the back so as to clamp down on the bronze nuts; there are two nuts to provide adjustments for wear.

The tool head is made up of a piece of soft steel, 1¼ in. wide by 2 in. thick by 2¾ in. long, fitted to the lever with a knurled thumbscrew, to lock it to the lever at the proper location. On the right side is a slot to receive a ⅞ in. high-speed tool, which is ground to a sharp V, and is held in the head by a hardened tool-steel bolt, with a taper head flattened on one side. A slot, ½ in. wide is cut through at the bottom of this head to receive a roller ½ in. wide and ⅞ in. in



Machine used for graduating special rules or gages

diameter, which rests on the work, and the distance the tool is set below the roller is the depth of the graduation. The center of the roller is on a line with the cutting edge of the tool.

The table is constructed of a piece of soft steel, 1¼ in. thick by 5 in. wide by 18 in. long and is supported by two ways, made of tool steel, hardened and ground, and lapped into the V's in the bottom of the table. On the top is a raised strip, ⅛ in. wide by 1/32 in. high, to aline the work against. A T-slot, running the full length of the table, holds the square heads of the bolts, which are used for clamping the work. A screw, op-

* Device presented by R. B. Loveland, toolroom foreman, Norfolk & Western, Roanoke, Va., at the annual convention of the American Railway Tool Foremen's Association at Chicago.

erated by a crank, moves the table in to the automatic stop.

The automatic stop is composed of a tool-steel disc, 1 in. thick by 4 in. in diameter, mounted on a ½ in. shaft and geared to the lead screw by a train of gears with which it is driven. One revolution of this disc represents one inch, and as one thirty-second is the finest graduation for which this machine is built, there are 32 pegs of hardened tool steel; one for each of the graduations. Each of the pegs is of proper length so that in graduating, one does not have to worry about the length of the marks. All that is necessary is to index the screw, and turn the handle on the front of the machine until the stop on the table engages the automatic stop, and then turn back until the table engages the back stop, which insured the tool being clear of the work, and then repeat the operation.

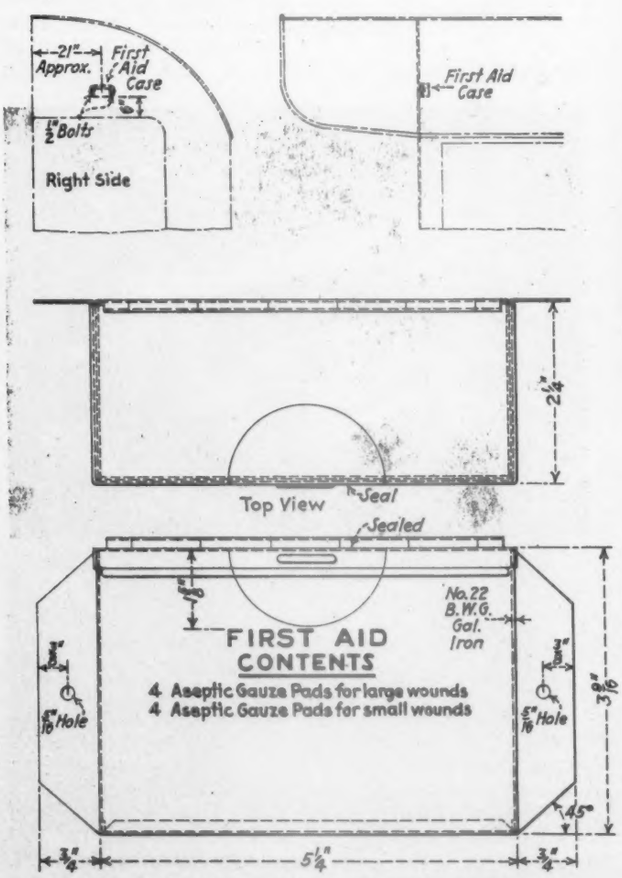
This machine is accurate and does neat regular work at a fair rate of speed for special jobs.

Locomotive First-Aid Cases

IN some states, particularly the state of Illinois, locomotives, both steam and electric, must be equipped with first aid cases to comply with the provisions of the state laws.

The accompanying sketches show the type of first aid case that has been made standard on one of the railroads operating in Illinois. It is made from No. 22 B.w.g. galvanized iron, painted black and lettered in white showing the first-aid materials which it contains.

An ordinary car seal is recommended for protecting the contents as the seals are numbered. A record can then be kept at the issuing engine terminal and the case replenished should it become necessary for the engine crew to make use of any article while in service.



The first-aid case and its location in the cab

A Circular Rack For Blue Prints

IN the machine shop of the D. & R. G. W., at Peublo, Colo., blue prints are made accessible and are at the same time kept clean by placing them on the welded pipe rack shown in the illustration. The 7-ft. section of 3-in. pipe which forms the central support of the rack is welded on a metal plate 18-in. in diameter which

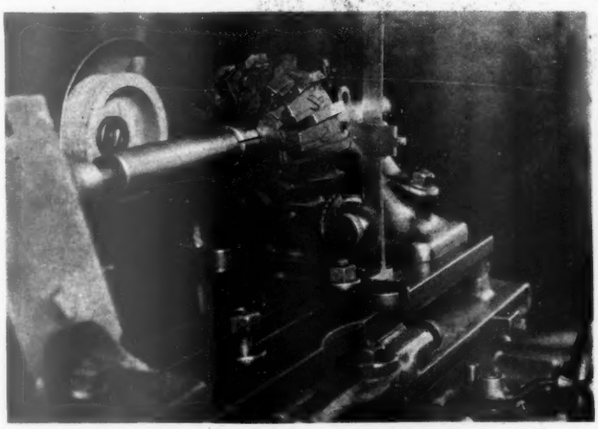
Circular rack used as a means for filing blue prints in the shop

is bolted to the floor. Two angle braces of 1-in. pipe, welded to the upright section and bolted to the floor aid in making the rack secure. A circular section of 1-in. pipe, used to hold the small prints, extends part way around the rack 3-ft. above the floor. It is supported by two angle braces of 1-in. pipe which are welded in place.

A complete circle of 1-in. pipe, supported by three horizontal and three angle braces of the same material is welded in place 5-ft. above the floor to carry the larger prints. Another circle of ½-in. pipe, welded to the top of five 10-in. vertical sections of 1-in. pipe, supports the canopy roof of sheet metal on its frame of 1-in. tubing. Metal hooks are placed in the stiff top bindings of the prints to facilitate their being moved about on the rack.

Gaging Cutter Clearance and Rake

THIS gage* for checking the clearance and rake of milling cutters and reamers consists of a base *C* graduated in degrees as on an ordinary protractor, reading 45 deg. either way from the vertical. This base is used to support the upright arm or protractor blade *B* to which the vernier, graduated to allow readings to five minutes, is attached. The head *A*, fitted to the arm



Clearance and rake gage as used for checking larger inserted-blade cutters

or protractor blade with a set screw, comes into contact with the cutter or reamer. The secret of success in connection with checking the angle clearance on cutters and reamers lies in this head.

A head made to fit an ordinary 12-in. scale and a protractor would serve, but when fitted up with the base as illustrated, it is possible to check cutters from ½ in. to 24 in. in diameter, which make it a universal tool

Clearance and rake gage as used for checking a small, solid milling cutter

for all cutters and reamers. One of the fine points of this tool is that it is only necessary to set up on the grinder in the ordinary way and bring the cutter or reamer into contact with the grinding wheel and grind just a spot, then turn and check with the gage.

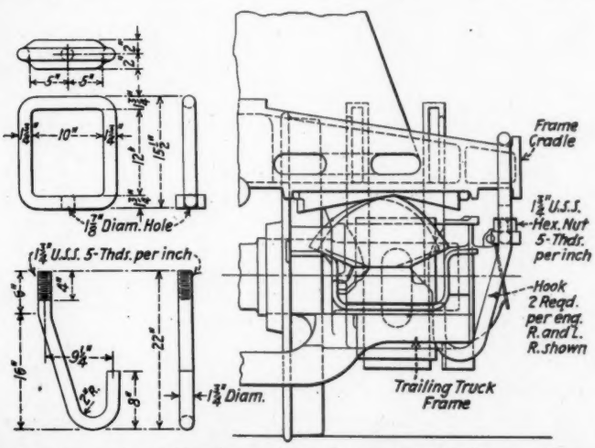
To adjust the head, which must be set even with the center of the cutter or reamer, first set the protractor at the desired angle, then use the center gage *D*, shown in one of the illustrations. The head can be used with a face for small cutters or with a face for large cutters.

It is purposed to work up a table of degrees for milling cutters and reamers for use in conjunction with this gage, and by stamping the table for cutters on one side of the blade and the table for reamers on the other, it will thus be possible to save considerable time and trouble. This table will be for general use. Cutters on reamers for special jobs, which require a different angle can be produced by making records of the angles used.

* Device submitted by R. B. Loveland, toolroom foreman, Northern & Western, Roanoke, Va., at the annual Chicago convention of the American Railway Tool Foremen's Association.

Dropping Trailer Wheels

A NUMBER of roads have classes of locomotives on which the hook shown in the drawing can be used for suspending the frame of a trailing truck when dropping the wheels. The hook and carrier can be



Design and application of the hook for holding trailing-truck frames when dropping the wheels

made in the blacksmith shop. The hooks, one on each side, are inserted under the frame of the trailing truck and the carrier is then slung over the end of the frame cradle. The nut is screwed down which draws the frame of the trailing truck and the cradle together. On completion of this operation, the wheels may be dropped while the frame will remain in position.

SLIP COACHES STILL IN USE.—The number of slip coaches now operating on the railroads of Great Britain is only 45, the practice having shrunk greatly from the year before the war when 177 such cars were operated. If any young American is at all hazy as to the definition of the term "slip coach" he should be reminded that it is a passenger car attached to the rear of an express train and which, with its passengers is detached from the train and stopped at a way station, without the stopping of the train.

The decline in the use of this arrangement is said to be due to the cost of additional brakemen, the need for specially fitted cars and the increasing use of corridor trains, on which passengers may desire to pass from the rear car to the dining car. The Great Western still has 34 daily "slips," though before the war there were on this road 70 or more. The London, Midland & Scottish, on whose lines there were before the war 44 such cars, now has none at all.

Left — How the rod looks at the end of the various steps required to form the jaw

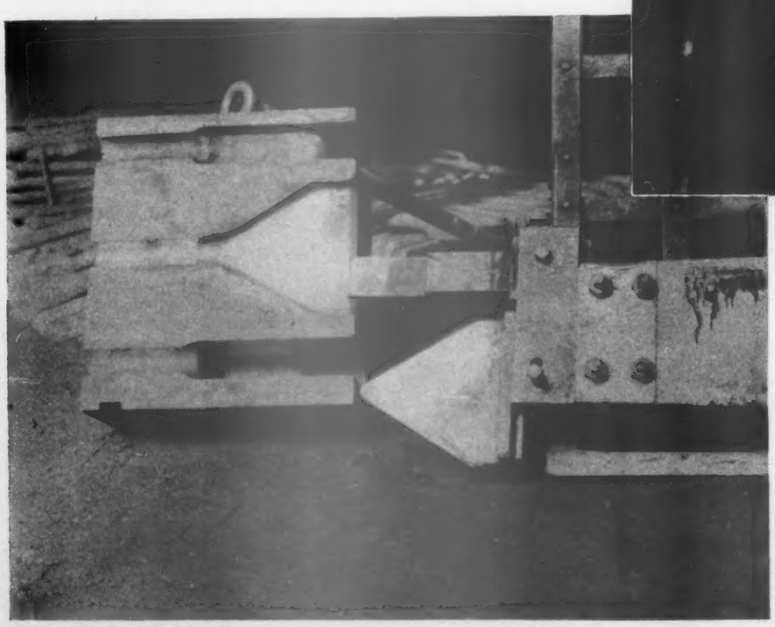
Making Brake Rods On an Acme Machine

SPECIALLY developed dies and headers for an Acme 5-in. forging machine have simplified the manufacture of brake rods in the blacksmith shop of the Denver & Rio Grande Western, at Denver, Colo. The die blocks, the left one of which is shown in one of the illustrations, are 18 in. wide, 22 in. long and 8 in. thick. An eye bolt is inserted in the top of the die blocks and header blocks to facilitate their handling by a hoist.

Three different openings are used to form the jaw. The 1¾-in. round stock is first heated to a white heat at one end and thrust into the middle opening in the dies and the metal is gathered and split by the V-shaped header. It is then placed in an opening at the bottom of the block and flattened with a header, spreading the jaws at right angles to the rod. It is then re-heated and placed in the upper die opening which is large enough to allow the rod to slide. The smaller header forces the rod into this die, forming the jaws. These are finished by placing them on an anvil and striking two or three blows with a hammer after placing a flat bar in the fork. The rod is then allowed to cool after which the other end is formed with the same process. When cool again the pin holes are drilled in the jaws.

This method has been found to save the work of one man, over the sawing method of forming the jaws and it is also preferred to the various welding processes.

Forging the jaws on the brake rods

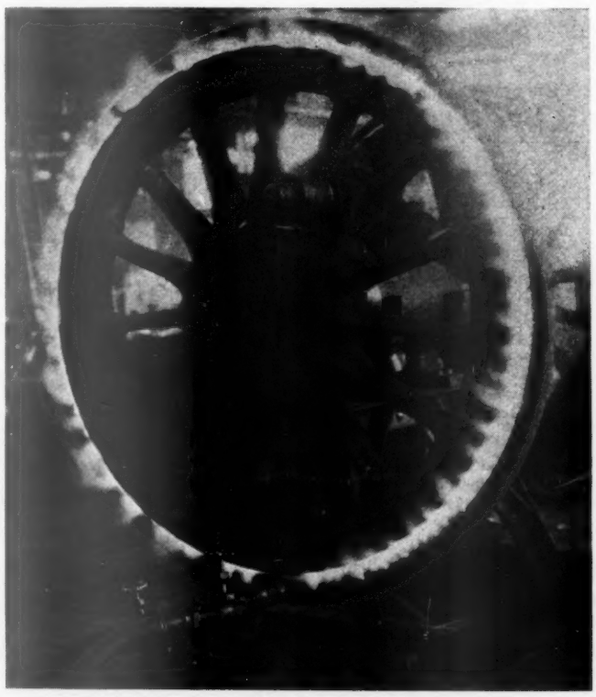


The V forming-die block and a pair of the forming headers

Gas Heat for Removing Tires

IN shops where most of the tire work is completed within the shop itself, the use of oil-heating apparatus often fills the building with a dense pungent smoke. Aside from creating uncomfortable working conditions it denotes an ineffective heating apparatus and an uneconomical consumption of the fuel. Confronted with these conditions, the wheel-shop foreman of the Pittsburgh and Lake Erie designed a gas-heating apparatus which produces an even flame of high intensity and which is capable of heating a tire in four minutes to the temperature necessary for removing or applying it.

The tire hoop is constructed of 1½-in. pipe, the gas opening being $\frac{1}{16}$-in. slits which are sawed in the pipe at 2-in. intervals. The junction of the air and gas lines is of a special design and was perfected only after considerable experimentation. It consists primarily of a converging air-delivery tube set in the line at the junc-



The gas flame is even and intense and heats the tire for removal in four minutes

tion of the two supply lines to facilitate the delivery of the gas to the hoop. The apparatus does not use an excess of gas and has proven to be far more economical than the oil heating equipment which it has replaced.

Press Jig for Removing Crank Pins

THE holding of a pin set against a block in the wheel-press housing until hydraulic pressure brings the press head against the wheel is one of the more or less dangerous practices followed in the wheel shop while removing crank pins. The jig shown in the

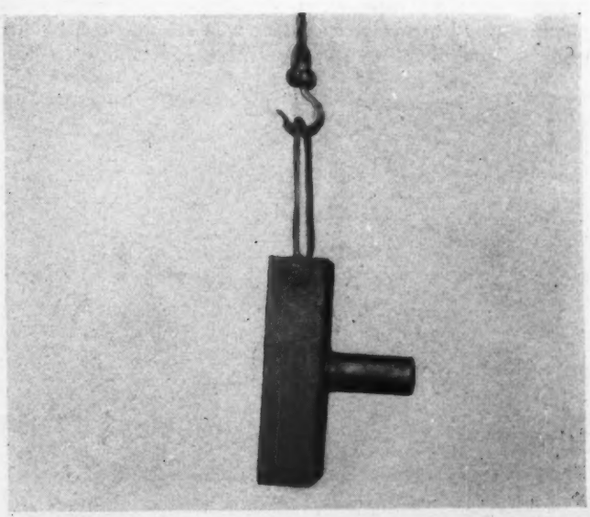
The jig eliminates the necessity of manually supporting a pin against the crank pin while the press head is being brought into position

illustration was designed expressly for the purpose of eliminating this practice by incorporating the pin and block in one piece and suspending them from a crane.

The jig consists of an 8-in. by 12-in. by 24-in. steel block, machined square and drilled to a diameter of 2 in. in the center of the 12-in. face. A 15/16-in. hole is drilled in the 8-in. face of the block, 1-15/16 in. from the top, for the insertion of a ⅞-in. bolt. It is drilled off the center line towards the pin face of the block so that the block will hang straight when suspended from the crane hook. The bolt is used to attach an inverted-U shaped handle to the block.

A set of pins of various diameters is used with the jigs to press out crank pins of various sizes. One end of each of the pins is machined to the same size to fit loosely in the 2-in. hole in the block. Thus only one steel block is necessary for any number of pins.

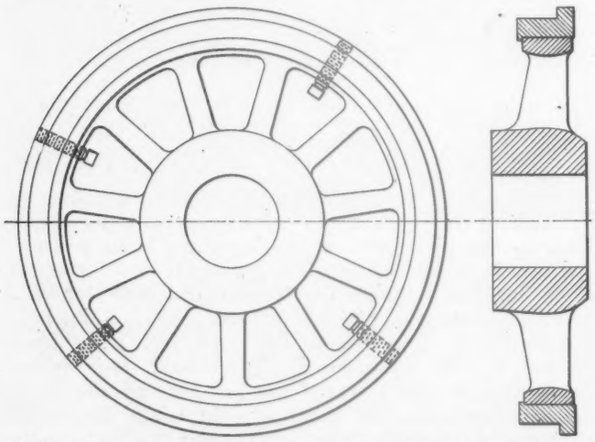
When in use, the pin of the size necessary for the removal of the crank pin is first chosen and set in the jig. The jig is then lifted into position against the wheel-press housing by the beam crane. The wheel or pair of wheels, as the case may be, is then swung into position, the pin of the jig being set against the crank pin on the inside face of the wheel. The wheel-press operator can steady the jig and the wheel with safety while the press head is being brought against the face of the wheel preparatory to applying the pressure for the removal of a crank pin.



The jig is a steel block suspended from a beam crane—Pins of various diameters can be inserted for the removal of a variety of crank-pin sizes

A Mandrel for Turning Tires

IN one of the illustrations is shown a pair of 44-in. driving tires mounted on a mandrel preparatory to machining the tread contour. The mandrel consists of a scrap pair of trailer-wheel centers and tires mounted on an axle, the tires being shrunk onto the wheel centers and machined with a shoulder against which the

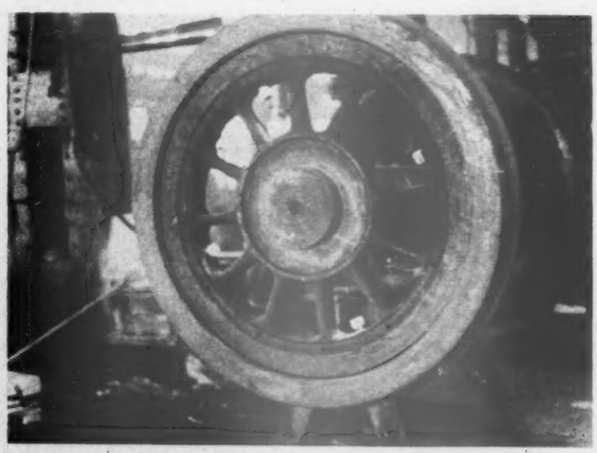


Trailer tires were shrunk on wheel centers and machined with a square shoulder to make this mandrel for turning driving tires

driving wheel tires are set during machining operation. The outside diameter of the trailer tires is machined $\frac{1}{16}$ in. less than the standard inside diameter of the driving-wheel tires which are to be machined.

When the driving tires are placed upon the mandrel, they are adjusted and centered by means of four set screws and a 1/32 in. liner. The pressure of the set screws is sufficient to hold the tires in place on the mandrel while it is being moved to the driving wheel lathe by a crane. After being mounted in the driving wheel lathe, the pressure of the chuck jaws against the tire prevents it from turning on the mandrel while the cut is being taken.

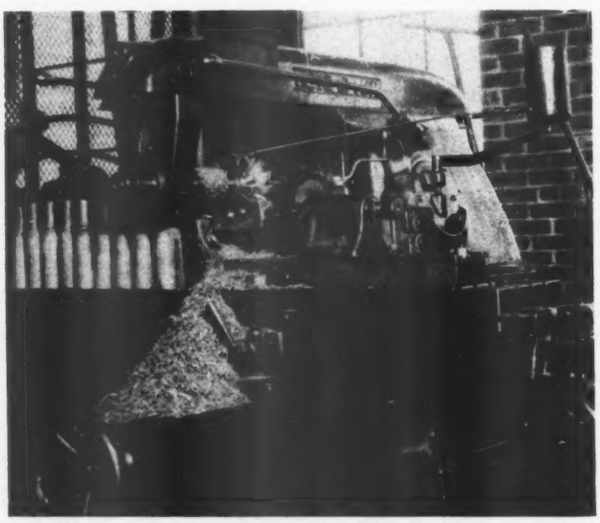
The mandrel was made in a wheel shop where a large number of tires were shipped from outside points for machining. Formerly, each tire was set up on a boring mill and machined at a cost of $1.40. A single pair of tires was thus machined at a cost of $2.80, plus 30 cents for set-up time, a total of $3.10. The wheel-lathe price for turning a pair of tires mounted on wheel centers, in the shop referred to is $1.25. By using the mandrel the foreman of the shop thus saved the difference between turning two single tires on a boring mill and turning a pair of wheels on the wheel-lathe, which in this case was $1.85, exclusive of the time of the machinist and machinist helper who mounted the driving tires upon the mandrel.



Driving tires set up on the mandrel preparatory to machining the flange and tread contour

Fixture for Milling Main-Rod Keys

IN the illustration is shown a method for milling, on a production basis, the flat sides and rod fit on keys for the front ends of main rods. The keys are held in



The milling operations on main-rod keys showing the slab and radially fluked cutters

an indexing fixture which has an adjustable head and center and which can be designed to hold several keys, the number depending on the size of the machine and the number of cutters which can be set up on the arbor at one time.

The keys, preparatory to milling, are centered on each end. They are then placed in the fixture and the two flat sides are milled with a slab milling cutter. After being revolved into a vertical position the semi-circular edge of the key is milled to the radius of the main-rod fit by a concave cutter, the radius of the flutes of which correspond to the radius of the main-rod fit.

TWENTY-FIVE YEARS AGO.—The maximum working pressure for locomotive boilers has been gradually increased with the general trend of enlarged proportions and the demand for greater power. In the United States this pressure has been nearly doubled in the past 30 years. For some years prior to 1880 the standard boiler pressure on many roads was 125 lb. In 1885, 150 lb. was used by the more progressive lines, and in 1890, 160 was quite generally used. In 1895 the pressure had increased to 180 lb., and in 1900, 200 lb. was tried by a few roads. While some roads have gone as high at 210 and 220 lb., there are now seen signs of a decided change, making 200 lb. the limit, with a tendency to go below rather than above it.—Railway Age, December 15, 1905.

NEW DEVICES

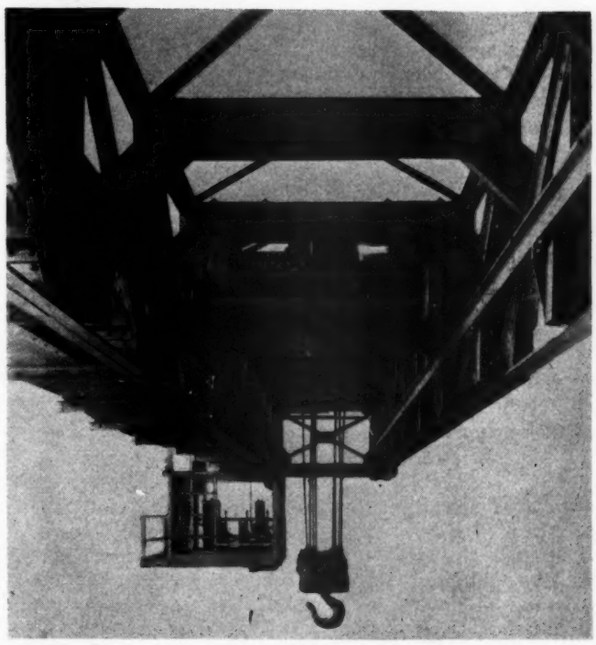
A 10-Ton Aluminum Crane

SIX very unusual overhead traveling cranes have recently been built by the Northern Engineering Works, Detroit, Mich., for the U. S. Aluminum Company of Pittsburgh, Pa., for its new sheet rolling mills located at Alcoa, Tenn. These cranes are especially interesting from several standpoints. The design and construction of the bridge is unusual and the crane, including the trolley, is made almost entirely from aluminum-alloy rolled structural sections and aluminum-alloy castings.

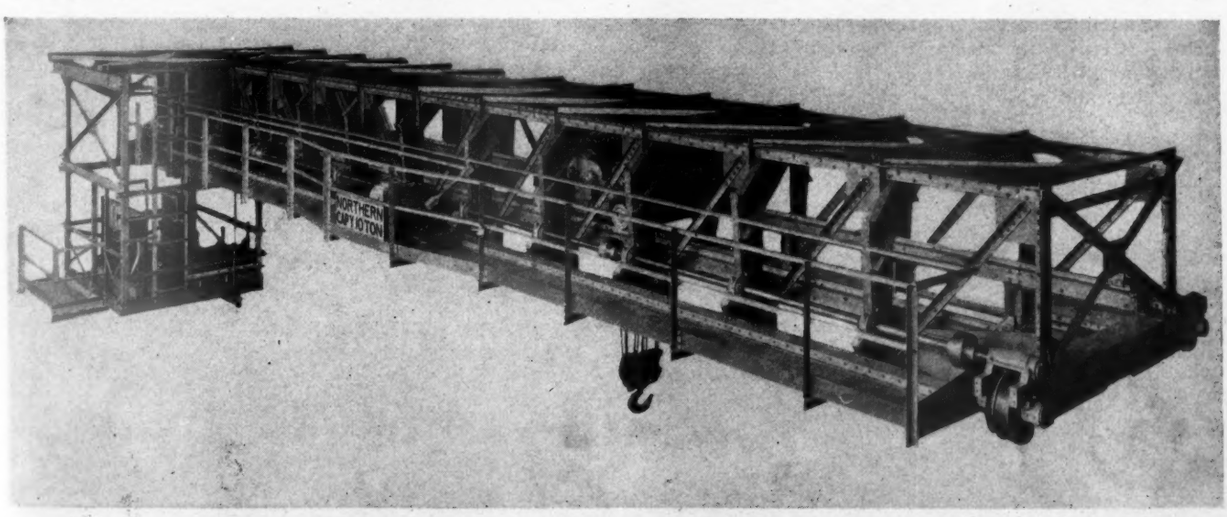
The crane illustrated has a capacity of 10 tons. The span of the bridge is 76 ft. 6 in. between truck wheels and the height of lift on the hoisting hook is 25 ft. Three mill-type motors, for 220-volt direct current, drive the hoist, bridge travel and trolley travel. They are provided with full magnetic control, placed in the operator's cab which is located at one end of the bridge. The hoist operates at a full-load speed of 50 ft. per min. and is provided with a 19-hp. motor. The bridge, fully loaded, travels at a speed of 400 ft. per min. and is also provided with a 19-hp. motor. The trolley is driven by a 4½-hp. motor and travels at a speed of 150 ft. per min.

The crane bridge is of latticed girder construction. The design not only accomplishes a saving in headroom, which was a factor in this installation, but reduces the weight of the structure under what it would have been with the conventional steel-plate girder section. It is interesting to note that all the rivets used in the structure, the T-rail on which the crane trolley runs, including the hook bolts and nuts that secure it to the girders, and all bolts, nuts, electric conduit and fittings are of aluminum. The footwalk which runs the full length of the bridge is made up entirely from aluminum, including the checkered floor plates.

The trucks which carry the bridge are aluminum castings, made from No. 195 alloy. All of the gear housings, gear covers, bearing housings, transmission cases and covers, and line-shaft bearings were made from aluminum alloy. The main line or driving shaft extending the full length of the bridge, which drives both end trucks, was made from aluminum and has a hollow center. The shaft is carried in self-aligning bearings spaced at regular intervals and the bearings are equipped for Alemite forced lubrication. Aside from the saving in weight due to the nature of the material employed, every part and member entering into the construction of the finished crane was designed for minimum weight and at the same time for maximum



A view of the bridge between the girders showing the crane trolley

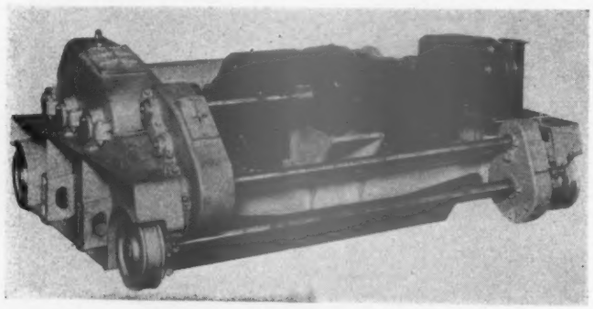


The 10-ton crane of all aluminum construction built by the Northern Engineering Works

effectiveness at the point where it was intended to function.

The bridge consists of two latticed-type girders with overhead bracing. The footwalk is attached to the lower chord of the left-hand girder which also supports the operator's cab. The operator's cab contains all the controls, magnetic panels, and complete switchboard equipment for the operation of the three motors located on the crane. The operator's cab like the rest of the crane bridge was made up from rolled aluminum structural plates, angles and rivets.

The trolley used on the crane is a standard Northern type NE fully enclosed crane trolley. The trolley sides or trucks, which include the lower portion of the gear housings, were made from aluminum-alloy castings as were the gear housing covers, bearing housings, and the connecting girt between the two trolley frames. The



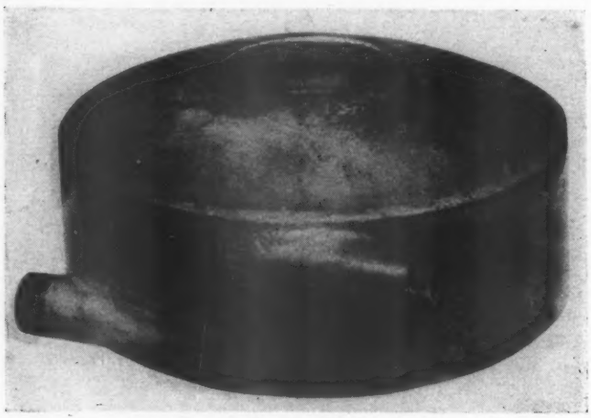
The crane trolley, the castings of which are all of aluminum alloy

trolley is of aluminum and is of double-girt construction, which permits the live-load stressed to be brought directly into the trolley sides. One of the girts is a rigid cast aluminum-alloy member that connects the two trolley sides and holds the trolley in rigid permanent alinement. Aside from this purpose it serves to carry the hoist motor but does not carry any of the live load. The other is a structural aluminum girt which carries the live load directly into the trolley sides and it is free to adjust itself to varying stresses. The trolley is provided with Hyatt roller bearings throughout the hoisting and traveling mechanism, and all bearings are furnished with Alemite forced lubrication.

Some interesting figures regarding relative weights of this crane employing aluminum and the same crane built of steel and iron can be given. The weight of the structural parts of the bridge in aluminum and with the latticed type girders is 16,300 lb. The same structural parts in steel and with the conventional plate-type box girder would have weighed 46,600 lb. The weight of the bridge complete without the trolley is 24,500 lb. In steel it would have been 58,000 lb. The weight of the trolley unit alone is 5,500 lb. In steel it would have been 8,300 lb. The total net weight of the entire crane, including the trolley, is 30,000 lb. In steel it would have been 77,100 lb. representing a total saving of 47,-100 lb. in the weight of the complete, finished crane in service condition.

Bird-Archer Blow-Off Muffler

A BLOW-OFF muffler which is a radical departure from previous types has recently been developed by the Bird-Archer Company, New York, and is being tested on a Chicago & North Western switching locomotive in the Chicago district. The B-A muffler, as it is called, is made in the form of a separator, mounted on top of the boiler, and connected by suitable piping to the blow-off cocks. The separation of the steam and sludge-filled water is accomplished by the application of the cen-



Centrifugal-type muffler which is located on top of the boiler

trifugal principle. The blow-down enters the cylindrical muffler tangentially. The water is thrown to the outside, draining off by gravity through a discharge pipe and being delivered to the ash pan and thence to the track. The steam is discharged vertically into the air

Bird-Archer blow-off muffler applied for test purposes to a Chicago & North Western switcher

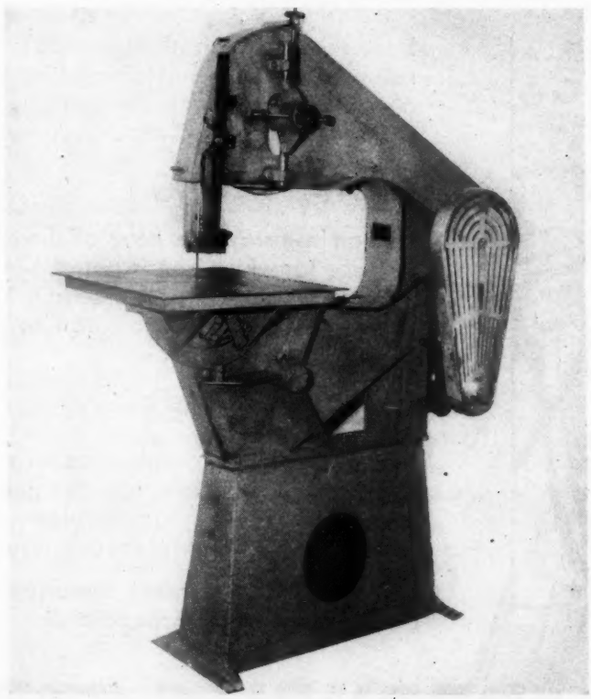
much like the discharge of the pops, except that there is much less noise.

Advantages claimed for the new B-A muffler design include satisfactory disposition of the blow-down with safety to all concerned; steam disposed of in such a manner as to cause no obstruction to the engineman's vision; absence of equipment or parts likely to clog up; delivery of sludge-filled water to the track without disturbance of the ballast or trouble due to blowing cinders or sand to the journals; consequent possibility of blowing off the boiler at any time needed, regardless of wind direction or wayside conditions.

All-Steel Fabricated Band Saw

A SERIES of all-steel fabricated band saws has recently been added to the line of the De Walt Products Corporation, Lancaster, Pa. The fabrication of the complete metal frame and stand was adopted to insure a machine which would be light in weight and of rugged construction, eliminating vibration, thus increasing the life of the saw blade.

The machines are built entirely by electric welding and are manufactured in two types, a two-wheel unit and



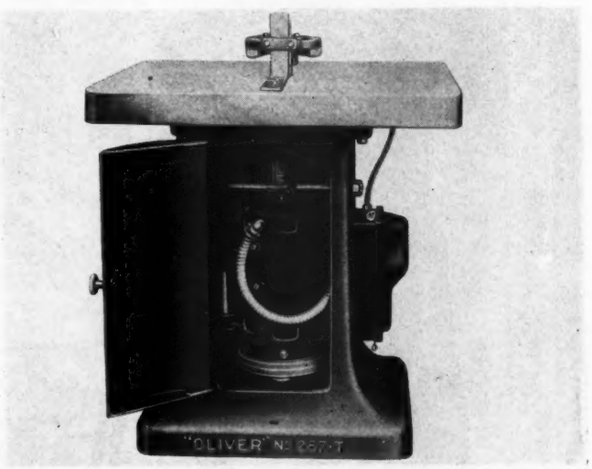
The De Walt band saw with all-steel welded frame and stand

a three-wheel unit. The two-wheel unit is a 16-in. capacity machine, while the three-wheel unit is built in capacities of 24 in. and 30 in. All models of the machine employ aluminum wheels 16½ in. in diameter mechanically balanced and mounted on Timken roller bearings with an adjustable tracking device for lining and adjusting the band-saw blade.

The use of the three pulley wheels was adopted in order to obtain greater throat clearance. The band-saw track and wheels are contained in one frame, completely enclosing all running parts, except that portion of the blade used in the cut. The ½-hp., ¾-hp., or 1-hp. motors with V-type pulley and belt, are included in the equipment furnished with the three types of saws.

A Single-Spindle Wood Shaper

THE latest developments in the products manufactured by the Oliver Machinery Corporation, Grand Rapids, Mich., is a single-spindle high-speed ball-bearing wood shaper or variety moulder. One of the outstanding features of the shaper is the high-speed spindle which makes it possible to feed the stock to the cutters with or against the grain in a single operation. The table is 36 in. square and 36 in. above the floor and, although that size table is standard equipment, larger



The Oliver high-speed wood shaper or variety moulder

tables can be furnished for special requirements. Dust chutes are cast integral with the table to prevent accumulation of dust near the spindle. A hole, 11 in. in diameter, in the center of the table has three large rings with flanges, the smallest of which has an inside diameter of 2 in. to allow the spindle adapter to rotate freely.

The Oliver detachable spindle, which is used on the shaper, has a wick-filter type of oil lubrication to prevent dust from entering the ball races. It is arranged with a brake connected to an automatic cut-off switch operated by a foot lever.

The shaper is built with the motor directly connected to the spindle with an aluminum fan built into the housing to keep the motor cool. The motor, yoke and spindle are raised and lowered as a unit by means of a hand wheel at the right of the operator. This motor drive require the use of a frequency changer or motor generator set giving a frequency of 100, 120 or 140 cycles to obtain speeds of 6,000, 7,200 or 8,400 r.p.m. respectively.

The machine may also be arranged for a belted motor drive operating with a 3,600 r.p.m. ball-bearing motor mounted in a vertical position with an endless fabric belt transmitting the power to the spindle.

A third method consisting of a V-belt motor drive, developed by the Oliver Machinery Company, is unique

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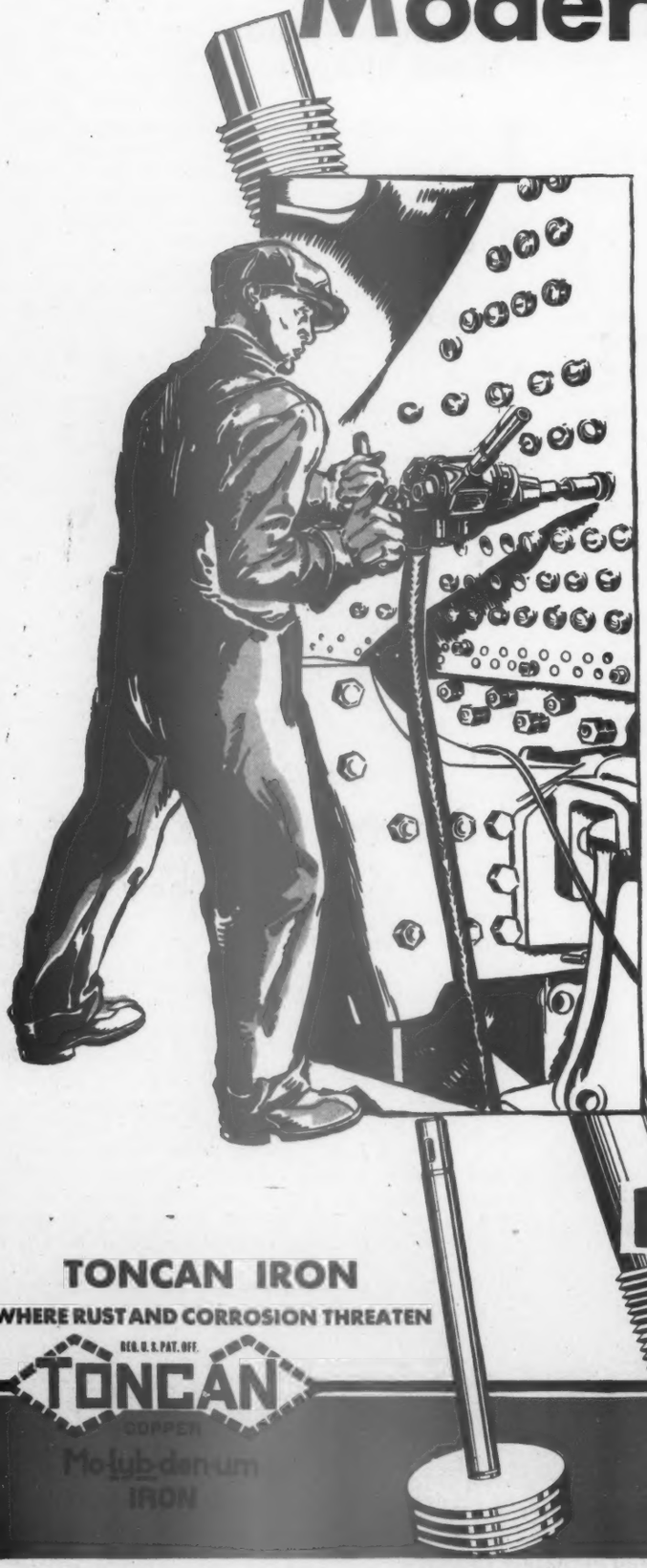
Modern Materials R



● Just as the locomotive designer has re
moved the handicaps that limited locomotiv
power so, too, have Republic metallurgist
removed the handicaps that the old materia
placed on dependable operation and o
maintenance.

In Toncan Iron, Republic metallurgists hav
developed a modern iron, uniform in com
position, that has superior resistance to ru
and corrosion.

Toncan Iron is now being widely used for:—

● BOILER TUBES

Here the corrosion resistance of Toncan Iro
results in longer tube life. Toncan Iron tubes ar
also seamless, and cold working leaves the cor
rosion resistance of Toncan Iron unimpaired

● STAYBOLTS

Toncan Iron staybolts have all the fatigue re
sistance for which iron is noted, but are fre
from all slag pockets and seams. Then, too
the resistance of Toncan Iron to corrosion
prolongs staybolt life.

● CAR PLATES

Because of Toncan Iron's superior resistance
to rust and corrosion, car designers found
it possible to specify lighter plates, thus sav
ing a ton in the weight of the average gondola

But problems other than corrosion confron
the railroad mechanical official.

REPUBLIC STEEL

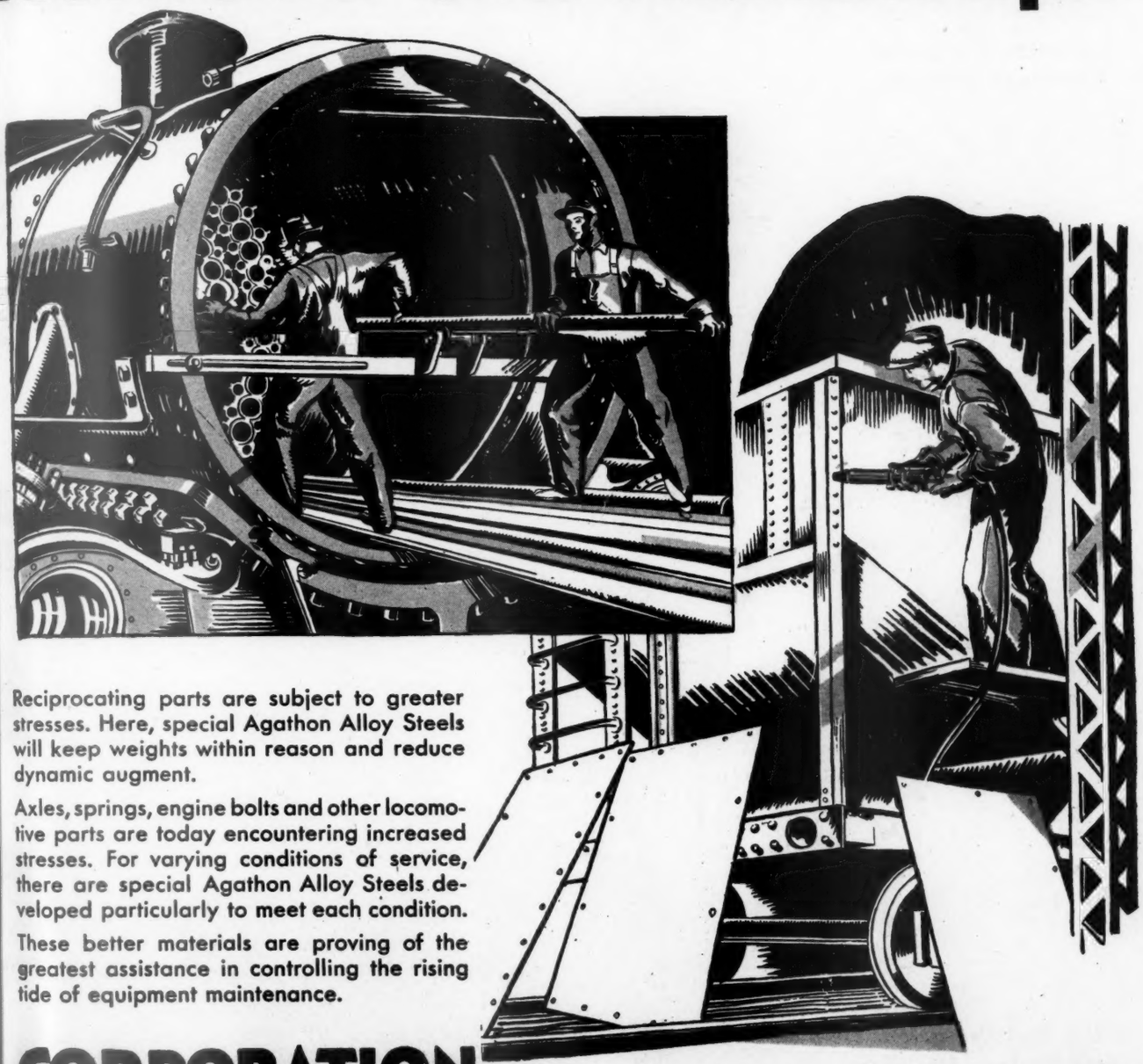
Central Alloy Steel Division

TONCAN IRON

WHERE RUST AND CORROSION THREATEN

REG. U. S. PAT. OFF.
TONCAN
COPPER
Molyb-den-um
IRON

Remove Old Handicaps



Reciprocating parts are subject to greater stresses. Here, special Agathon Alloy Steels will keep weights within reason and reduce dynamic augment.

Axles, springs, engine bolts and other locomotive parts are today encountering increased stresses. For varying conditions of service, there are special Agathon Alloy Steels developed particularly to meet each condition.

These better materials are proving of the greatest assistance in controlling the rising tide of equipment maintenance.

CORPORATION

Massillon, Ohio

AGATHON ALLOY STEELS

WHERE TOUGHNESS, STRENGTH OR LIGHTER WEIGHT ARE NEEDED

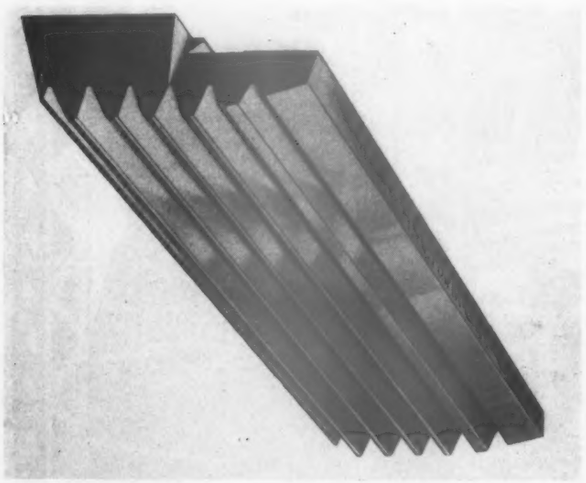
AGATHON STEELS

in that it gives compact drive for any high-speed shaper without the use of a frequency changer. Back of the shaper-spindle yoke is suspended a 3,600 r.p.m. vertical ball-bearing motor in a self-contained adjustable arrangement, with a twin V-belt type of drive reaching from the lower end of the motor to the lower end of the shaper-spindle to give a spindle speed of 7,200 r.p.m.

Landis Ground Thread Chasers

THE Landis Machine Co., Inc., Waynesboro, Pa., has developed and placed on the market a ground thread chaser which is designed to insure a high degree of thread accuracy. The thread form is ground on special grinding machines, the process removing the minor inaccuracies and distortions resulting from the heat treatment and producing a uniform thread form with a flat crest and root.

The ground thread form was adopted to obtain greater accuracy and freer cutting action in order to increase the life of the chaser between grindings. The ground thread chasers are available for all sizes of Lanco and Landex die heads and for the 5/8-in., 7/8-in., 1¼-in. and 2-in. Landmatic die heads.



The Landis ground thread chaser for Lanco, Landex and Landmatic die heads

The Hisey TexDrive Buffer

THE Hisey Model M TexDrive buffing and polishing machine with open type spindle extensions is the latest addition to the line of grinding equipment manufactured by the Hisey-Wolf Machine Company, Cincinnati, Ohio. The machines are available in 3-hp., 5-hp. and 7½-hp. sizes. They are designed with the Hisey gooseneck construction, the spindle and buffing wheels extending out from the base of the machine to permit easy handling of large or odd-shaped pieces. The motor mounting is of the external type with a rigid four-point support, Tex-rope drive being utilized to transmit power to the spindle. The motor is equipped with ball bearings and is furnished with a dovetailed sliding base including a gib with the necessary locking screws. Proper belt tension and accurate alinement of the motor is adjusted by means of a hand wheel and feed screw.

The spindle is of one-piece design made of nickel steel and machined to the exact diameter in order to insure balancing. The spindle is mounted in ball bearings, although Timken roller bearings can be furnished if desired. The bearing boxes are keyed to the column of the machine. The key is located along the entire base of the bearing housing and fits in a keyway on the top of the column. This design was adopted in order to insure perfect realinement of the bearing housing, regardless of how often the housing is taken off.

The Hisey model M TexDrive buffing machine

Compressor for Train-Line Charging

IN the illustration is shown a two-stage air-cooled compressor which is designed especially for train-line charging service. It is a self-contained unit mounted, together with a directly connected motor, on a single-sub-base. The unit, manufactured by the Ingersoll-Rand Company, 11 Broadway, New York, and designat-

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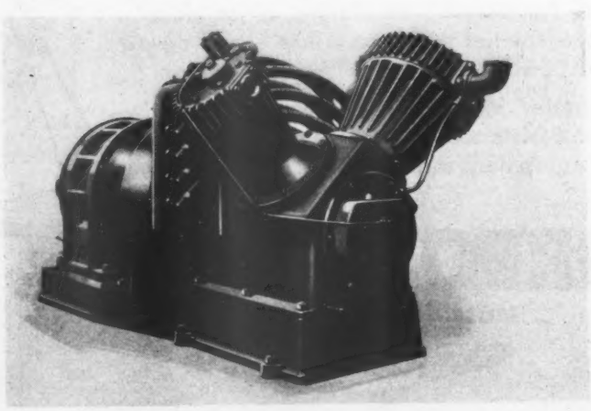


The Ingersoll-Rand type TIC compressor for charging train lines

This Traveling Power Plant Cuts Operating Costs

OPERATING conditions today demand the pulling of heavier trains at higher speeds.

Only by using locomotives capable of producing higher horsepower can train movement be speeded up without reducing tonnage.

Super-Power Steam Locomotives haul heavier trains faster; shorten the railroad and increase its capacity; reduce the number of locomotives necessary for a given operation; reduce train movement costs; reduce maintenance costs; and save fuel.

332 LIMA Super-Power Steam Locomotives have been purchased as the result of demonstrated reduction in operating costs.

LIMA LOCOMOTIVE WORKS
Incorporated
LIMA, OHIO

ed as its type TIC compressor, has a piston displacement of 155 cu. ft. per min. and is designed to furnish a discharge pressure of 100 lb. per sq. in.

It is equipped with automatic stop-and-start control, which maintains a fixed air pressure and provides for operation only when air is being used. Ball bearings are used throughout the motor and compressor and these, together with other moving parts of the unit, are automatically lubricated. The motor is protected by an air-sealed unloader which unloads both cylinders and the intercooler whenever the compressor starts and stops. Pumping of oil is prevented by two oil-control rings and the moving parts are protected against dust and dirt by an enclosed crankcase.

Tensile-Testing Machine

A PORTABLE tensile-testing machine, designed to facilitate the testing of welds in the field and in the shop has recently been placed on the market by the Oxweld Acetylene Company, 30 East Forty-Second street, New York. It was developed in co-operation with the Union Carbide and Carbon Research Laboratories, Inc., weighs 165 lb., measures 28 in. in overall length and is 6¾ in. in maximum diameter. It consists of a tubular compression member with a set of grips in the head and a hydraulic cylinder block in its base. The cylinder block contains a communicating pump and cylinder directly machined into a single block, the cylinder pressure operating a piston carrying a second set of grips.

The specimen to be tested is placed between the jaws, which have spring grips. When operating, a release valve is closed and the pump handle applied at the end of the cylinder is moved back and forth. A set of conical blocks has also been constructed to fit into the machine head in place of the grips so that the standard ½-in. round specimens may be tested if desired. The load is measured directly in pounds per square inch by a suitable, calibrated pressure gage actuated by the pressure in the cylinder. The gage is one of the essential parts of the apparatus. When a test is finished the pressure may be released by a valve and the piston may be returned by using the pump handle as a lever.

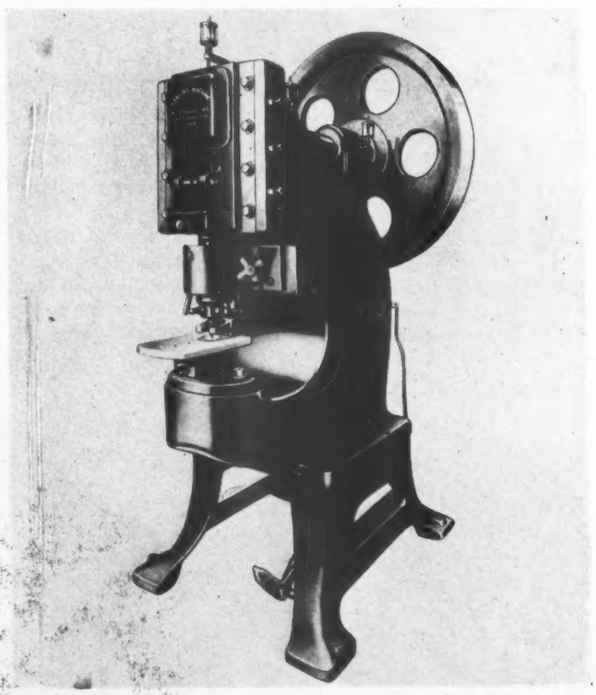
The Oxweld portable tensile-testing machine for weld specimens

This machine makes it possible to secure a tensile test result immediately after welds are made. It is used for determining welders' ability and also facilitates making periodic check tests of the operators and in many cases provides a ready means for testing sections cut at random by the inspector from completed work.

The machine is a self-contained, totally enclosed unit and when closed for shipment, presents a smooth cylindrical surface.

Campbell ¾-in. Capacity Nibbling Machine

THE Campbell No. 3 nibbling machine has been brought out by A. C. Campbell, Inc., Bridgeport, Conn., to fulfill the need for a machine for cutting all kinds of shapes from sheet metal ⅜ in. to ¾ in. in thickness. It is designed not only for cutting original



The Campbell No. 3 nibbling machine

pieces, but also for production work where the making of punches and dies is not desirable.

The machine cuts at a speed of approximately 20 linear in. per min. in any direction. Like the smaller nibbling machines it works on the circular punch and die principle with a pilot to prevent the work from slipping and the punch from taking too large bites. The cutting is clean without burr and very little finishing is necessary when a smooth edge is required.

It is designed to handle a large variety of work. Circles can be cut with a circle-cutting attachment which is furnished with the machine. For making original cuts the use of a straight edge and the French curve is recommended to insure close cutting to the line. The original piece may be used as a template for cutting duplicate pieces since the punch is designed to follow the template accurately. The machine has three strokes

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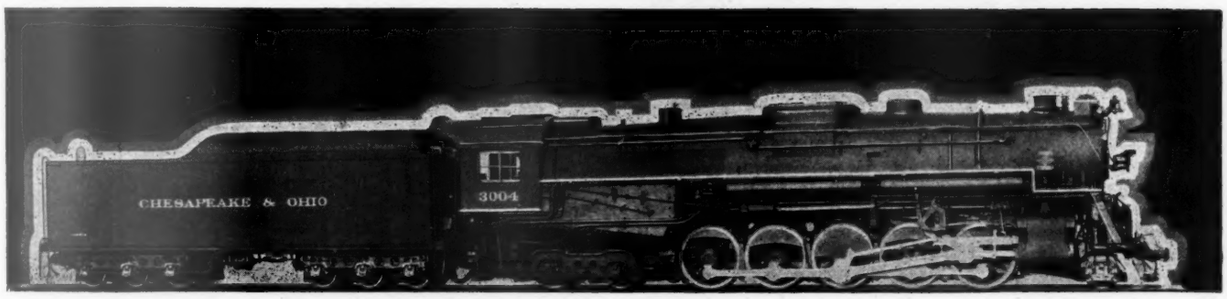
Chesapeake & Ohio 2-10-4 Out-Pulls the Mallet



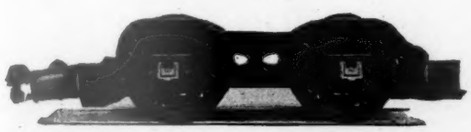
The LOCOMOTIVE BOOSTER *makes this new 2-10-4 the most powerful two-cylinder freight locomotive in the world*

TO the new Chesapeake & Ohio 2-10-4 type locomotives, The Locomotive Booster gives an additional 15,000 lbs. of tractive power, making them the most powerful two cylinder locomotives in the world.

Besides handling heavier loads at higher speeds, these locomotives are intended to reduce maintenance by replacing Mallets.

* * *

In deciding on the type of new power, remember that The Locomotive Booster supplies the starting power of another pair of drivers. Incorporating it in the new design will save the increased maintenance that would otherwise be involved in the use of another pair of drivers.



This elimination of a pair of drivers saves from 5 to 10 cents per locomotive mile and at a cost of only half a cent per mile for Booster maintenance. Enough to justify the Booster many times over, and to result in a large percentage increase in net income.

FRANKLIN RAILWAY SUPPLY COMPANY, Inc.

NEW YORK CHICAGO SAN FRANCISCO ST. LOUIS MONTREAL

—1 in., 13/16 in. and ½ in.—with a capacity for handling all thicknesses of sheets from ⅜ in to ¾ in. A ⅞-in. punch can be set in the die by turning the stroke adjustment collar. The stripper plate is set in correct position by releasing the locking lever and turning the handwheel.

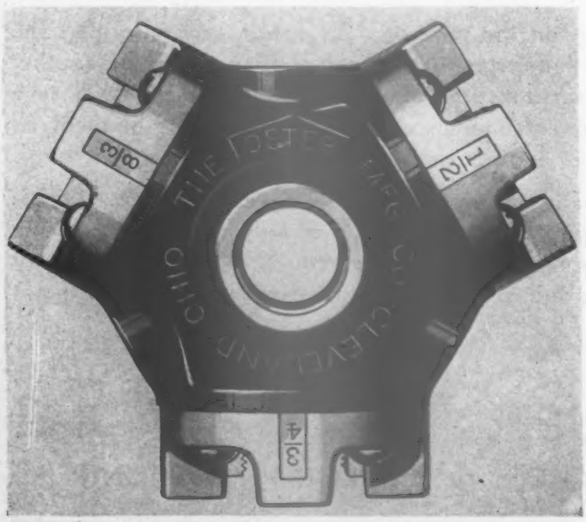
The following are the specifications for the machine: floor space required without motor, 5 ft. by 4 ft. 2 in.; height over wheel, 8 ft. 6 in.; pulley size, 50 in. diameter by 7½ in. face; pulley speed, 105 r.p.m.; depth of throat, 15 in.; horsepower required, 7½ hp.; net weight, belt drive, 9,000 lb.; shipping weight, belt drive 9,500 lb.; maximum cutting capacity, ¾ in.; punch diameter, ⅞ in.

Heavy-Gear Lubricants

A SERIES of gear lubricants for all types of heavy, low moving, open gears, has recently been brought out and designated as the Tenac No. 1, No. 2, No. 3 and No. 4 greases by the E. F. Houghton & Company, Philadelphia, Pa. Of these various grades of Tenac, the No. 1 is the heaviest of the series, while No. 4 is the lightest grade. Tenac No. 3 and No. 4 can operate satisfactorily where low atmospheric temperatures are encountered. No special device or method of application is required with the use of the Tenac series, their application to the gears being taken care of in the same manner as other lubricants used for the same purpose. The Tenac series was developed in order to provide lubricants of consistency that would not be thrown off the gears while in motion and which would decrease frictional losses by overcoming metal to metal contact.

Three-Way Tool Threader

A THREE-way threader for ⅜-in., ½-in. and ¾-in. pipe that will cut a standard-length thread on a pipe as close as 4⅝ in. to a wall, has recently been developed by The Oster Manufacturing Company and the Williams Tool Corp., of Cleveland, Ohio. This threader, designated as the No. 000 Chip Chaser, uses the same open type die holders as the regular Oster Chip Chasers, allowing a large area for oiling and chip clearance. The No. 000 threader is small, light in weight and is equipped with a large size ¾-in. handle.



The Oster three-way tool threader for threading pipe close to a wall

Semi-Flex Hacksaw Blade

THE L. S. Starrett Company, Athol, Mass., recently placed on the market its Semi-Flex hacksaw blade. The Semi-Flex, as the name implies, is flexible and is designed for use on jobs that strain or twist the blade.

The Semi-Flex blade being used on angle-iron which usually chatters and binds when cut by the ordinary type of blade

It is made of tungsten steel and tempered to prevent shelling of the teeth.

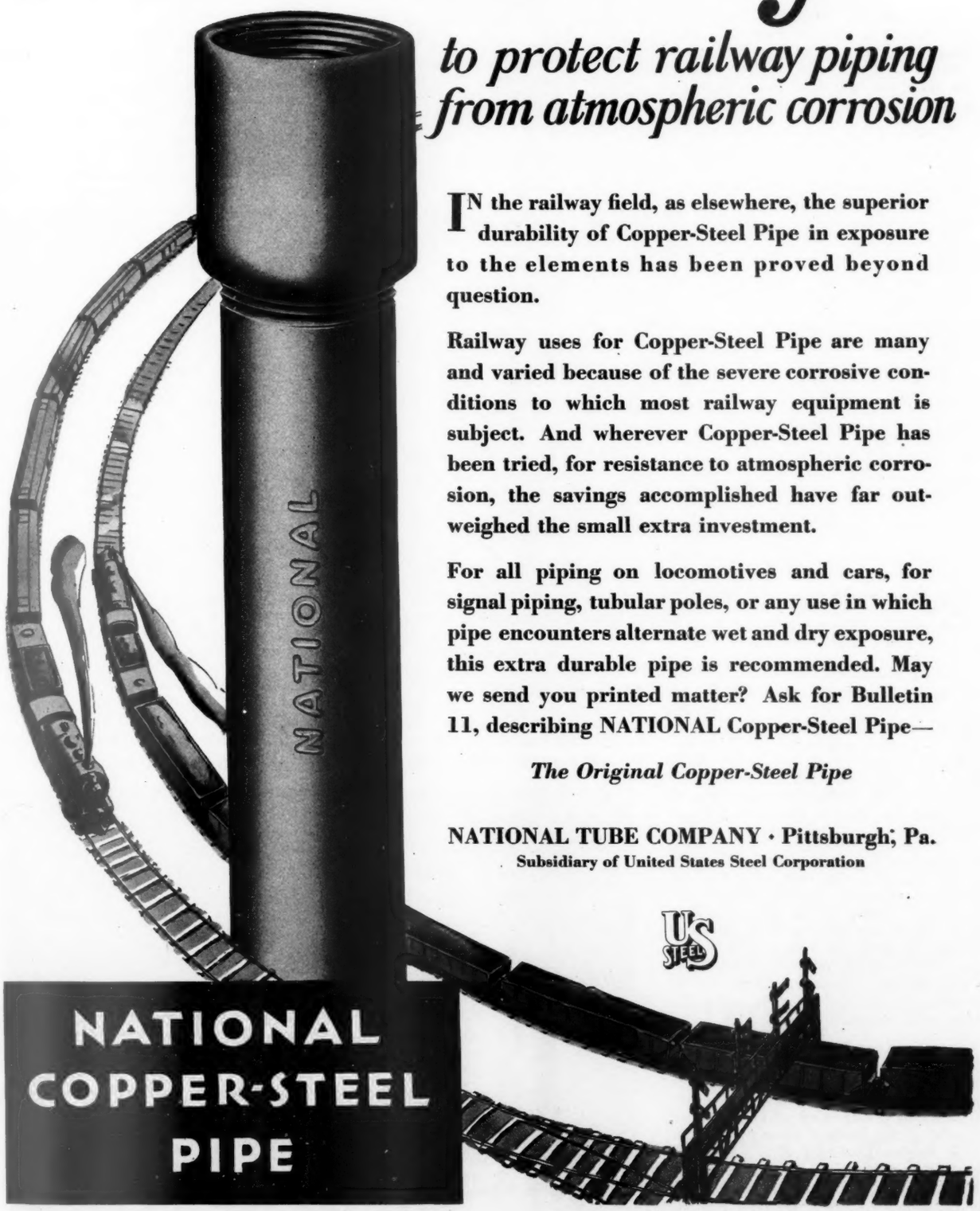
It was developed to take care of troublesome jobs such as the cutting of pipe, angle iron, wire cable, electric conduit, BX cable and similar soft or thin materials which cannot be cut readily by the ordinary type of blades.

SMALL MODELS.—The recent show of the Model Engineers of Great Britain rather specialized in tiny exhibits. Among the models constructed to extremely small scales was an 0-6-0 tank locomotive in L.M.S. colors, claimed to be the smallest working steam locomotive in the world. It had an overall length of 4¾ in. and was capable of running continuously for 12 min. It was driven by a small oscillating cylinder connected by gearing to the driving wheels, and would haul a load of 2 lb. 10 oz. Another miniature locomotive was a small Southern Railway 0-4-4 tank engine barely 2 in. in length and weighing just under 1 oz. It was operated by an electric motor concealed in the boiler, running at over 8,000 r.p.m. and giving a locomotive speed of 2 m.p.h. The engine was mounted in a case complete with a short length of track.

(Club and Association News on next left-hand page).

There is a way–

to protect railway piping from atmospheric corrosion



IN the railway field, as elsewhere, the superior durability of Copper-Steel Pipe in exposure to the elements has been proved beyond question.

Railway uses for Copper-Steel Pipe are many and varied because of the severe corrosive conditions to which most railway equipment is subject. And wherever Copper-Steel Pipe has been tried, for resistance to atmospheric corrosion, the savings accomplished have far outweighed the small extra investment.

For all piping on locomotives and cars, for signal piping, tubular poles, or any use in which pipe encounters alternate wet and dry exposure, this extra durable pipe is recommended. May we send you printed matter? Ask for Bulletin 11, describing NATIONAL Copper-Steel Pipe—

The Original Copper-Steel Pipe

NATIONAL TUBE COMPANY · Pittsburgh, Pa.
Subsidiary of United States Steel Corporation

Among the Clubs and Associations

CAR FOREMEN'S ASSN. OF CHICAGO.—At the meeting of the Car Foremen's Association of Chicago which will be held on January 12 at 8 p. m. at the Great Northern Hotel the new A. R. A. rules will be discussed.

CLEVELAND RAILWAY CLUB.—The A. R. A. mechanical rules effective January 1, 1931, will be discussed at the meeting of the Cleveland Railway Club which will be held at 8 p. m. on January 5 at the Hotel Hollenden, Cleveland, Ohio.

RAILWAY CAR MEN'S CLUB OF PEORIA AND PEKIN.— Changes in interchange rules will be discussed at the meeting of the Railway Car Men's Club of Peoria and Pekin which will be held at the Union Depot, in Peoria, Ill., on January 16 at 7 p. m.

EASTERN CAR FOREMEN'S ASSOCIATION.—The January 23 meeting of the Eastern Car Foremen's Association will be held at 29 West Thirty-Ninth street, New York, at 8 p. m. T. O'Donnell will lead in a discussion of the A. R. A. Rules of Interchange.

ST. LOUIS RAILWAY CLUB.—Further Possibilities of Efficiency in Railroad Transportation will be discussed by D. L. Forsythe, general road foreman of equipment of the St. Louis-San Francisco, before the meeting of the St. Louis Railway Club which will be held at 8 p. m. on January 9 at the Hotel Statler, St. Louis, Mo.

PACIFIC RAILWAY CLUB.—Fred W. Venton, assistant manager, railroad sales department, Crane Company, will be the speaker at the meeting of the Pacific Railway Club which will be held on Thursday evening, January 8, at 7:30 at the Hotel Oakland, Oakland, Cal. Mr. Venton's topic will be the Proper Method of Piping a Locomotive; How to Eliminate Screwed Joints.

CANADIAN RAILWAY CLUB.—The Hon. J. H. Rainville, chairman of the board, Montreal Harbour Commissioners, will present an address on the subject of Free Ports before the meeting of the Canadian Railway Club to be held at 8 p. m. on January 12 at the Windsor Hotel, Montreal, Canada. Moving pictures will be shown previous to the address by the Honorable Rainville.

NEW ENGLAND RAILROAD CLUB.—"Peace River Surveys and Canadian Pacific Branch Lines" will be the title of the paper to be presented by T. C. Macnabb, engineer of construction of the Canadian Pacific, at the January 13 meeting of the New England Railroad Club which will be held at 6:30 p. m. at the Copley-Plaza Hotel, Boston, Mass. This meeting will be the annual feature of the New England Railroad Club designated as Canadian Night.

INDIANAPOLIS CAR INSPECTOR'S ASSOCIATION— The next meeting, to be held at Hotel Severin, Indianapolis, Ind., on January 5, 1931 will be devoted primarily to a discussion of the changes in the A. R. A. Interchange Rules. The discussion period will be preceded by a 15-min. safety talk by a representative of one of the railroads in Indianapolis. There will be a noon-day luncheon meeting of the executive committee at the Hotel Severin on the above date at which any who are interested in car department matters are invited. At the January meeting of the association the following new officers, elected at the December meeting, will be installed: Chairman, L. C. Geisel, district master car builder, C. C. C. & St. L.; vice-chairman, W. L. Thayer, car foreman, C. I. & L. and secretary-treasurer, E. A. Jackson, A. R. A. inspector, N. Y. C. & St. L.

A.S.M.E. Holds Fifty-First Annual Meeting

American Society of Mechanical Engineers.—Meeting held December 1 to 5, inclusive, Engineering Societies Building, 29 West Thirty-Ninth street, New York. Fifty-first annual meeting; total registered attendance 2,657. ¶ In addition to a program of 72 technical papers on a variety of mechanical engineering subjects contributed by 14 professional divisions of the society and a large number of reports by research and technical committees, the annual meeting was featured by an exhibit of over 200 paintings, etchings and sculpture done by engineers who have followed art as an avocation. A series of three lectures on "Talking with an Audience" were given by Dr. S. Marion Tucker, head of the Department of English, Brooklyn Polytechnic Institute. A general conference on employment was held under the sponsorship of the American Engineering Council and at the request of Col. Arthur S. Woods, chairman of President Hoover's Emergency Committee for Employment. Colonel Woods and L. W. Wallace, executive secretary of the American Engineering Council, presented the problem for discussion at this conference. ¶ Roy V. Wright, editor, *Railway Mechanical Engineer,* and managing editor, Railway Age, was inducted into office on Tuesday evening, December 2, as president of the society for 1931. This meeting was also featured by a discussion on engineering, economics, and the problem of social well-being by Ralph E. Flanders, manager, Jones & Lamson Machine Company, Springfield, Vt., and a vice-president of the A.S.M.E., and Dr. Wesley C. Mitchell, director of the National Bureau of Economic Research, New York. ¶ The Railroad Division, as in previous years, developed its program for the annual meeting from papers of particular interest to railway mechanical engineers contributed by other professional divisions of the society. This program was published on page 665 of the November issue of the *Railway Mechanical Engineer.* The division program consisted of three papers and the annual report of progress in railway mechanical engineering during the past year. A. F. Stuebing, vice-president, Bradford Corporation, New York, and chairman (1930) of the Executive Committee, Railroad Division, presided at the first session, Tuesday morning, December 2. The first paper pre-

(Continued on next left-hand page)

The Twelfth Street coach-yard of the Illinois Central at Chicago during the blizzard of December 17, 1929

HERE'S THE ANSWER..

The increased weight and speed of modern freight transportation throw a tremendous burden on equipment. Any railroad executive, in doubt as to what wheels have the stamina to endure the stress of this heavy-duty service, will find the answer in Carnegie Light Weight Wrought Steel Wheels for freight cars of 70-ton capacity or less. They are safe . . . as only wrought steel wheels can be. They are durable . . . rendering long and continuous service. They are economical . . . insuring a lower cost-per-mile than any other type of freight car wheel.

Carnegie Light Weight Wrought Steel Wheels have answered the wheel question to the satisfaction of many prominent railroad officials. More than half a million wheels of this type are now in service. They offer a satisfactory solution to your wheel question.

US STEEL

CARNEGIE WROUGHT STEEL WHEELS

Product of Carnegie Steel Company, Pittsburgh, Pa., Subsidiary of United States Steel Corporation 100

sented was on "High-Pressure and High-Temperature Steam for Locomotives," by Dr. C. F. Hirshfeld, chief of research, the Detroit Edison Company, Detroit, Mich. The second paper was by R. Roosen, chief engineer, Henshel & Sohn, A. G., Kassel, Germany, on "The Stug System of Pulverized Fuel-Firing on Locomotives," and which was presented by W. H. Winterrowd, vice-president, Lima Locomotive Works, Inc. ¶ The entire afternoon session, which was presided over by Eliot Sumner, assistant to the general superintendent of motive power, Pennsylvania, and chairman (1931) of the Executive Committee, Railroad division, was devoted to the presentation and discussion of a paper by T. H. Symington, president, T. H. Symington & Son, Inc., Baltimore, Md., on "Research Relating to the Action of Four-Wheel Freight-Car Trucks." An abstract of Dr. Hirshfeld's paper, Mr. Symington's paper and a summary of the ensuing discussions are included in this issue. An abstract of Mr. Roosen's paper will be published in a later issue. ¶ An additional attraction held in connection with the annual meeting of the A.S.M.E. was the ninth national exposition of power and mechanical engineering, which was held during the same week in the Grand Central Palace, New York. Over 400 firms exhibited products, of which over 50 were manufacturers of small tools and machine tools. The remainder, about 350, were exhibitors of power-plant boilers and accessory equipment.

Club Papers

Cleveland Union Terminal Electrification

Cleveland Railway Club.—At the December meeting of this organization, held at the Hotel Hollenden, Cleveland, Ohio on December 1, 1930, H. W. Pinkerton, electrical engineer, Cleveland Union Terminals Company gave a talk on the electrification problem of the new Cleveland Union Terminal. ¶Mr. Pinkerton pointed out that this electrification project should be of exceptional interest to railroad men because of the fact that it is the first 3,000-volt direct-current installation in the East applied to a main-line railroad where heavy passenger traffic is involved. His talk indicated the complexity of the problems that had to be considered before the final selection of the equipment for the terminal could be decided upon in view of the grade and curve conditions encountered in the 16-mile territory which makes up the electrified zone. ¶Mr. Pinkerton explained in detail the equipment installed to operate the trains in the terminal district and in his talk told of the facilities that have been included for the proper maintenance and inspection of the electric locomotives.

Air-Brake Equipment

Manhattan Air Brake Club.—Meeting held December 17 in Room 2300, 150 Broadway, New York. ¶ The members of the Manhattan Air Brake Club discussed the following subjects at its December meeting; No. 6-E and No. 6 distributing valves; U-12-B universal valve; Limits of piston-flange thickness of pistons to be regrooved; Gas-electric rail car equipment, and variable release valve for auxiliary reservoirs. ¶ An expression of opinion was asked of the members as to the results being obtained with the 3/64-in. service port in the No. 6-E distributing valve and whether or not any difficulties were being experienced in meeting the sensitive tests for service port capacity and emergency, respectively. Information was requested as to the average condition of the ½-in. ball check in the emergency slide valve and the ⅛-in. choke plug with a 1/16-in. hole in the port leading to the emergency piston of the U-12-B universal valve when removed at regular cleaning periods. ¶ Information was given as to the limits of piston-flange thickness of pistons sent to the air brake department to be regrooved for various air-brake devices such as the equalizer piston of various types of universal valves, the main pistons of K and L triples, etc. The modified No. 6 ET equipment for gas-electric rail cars was described and explained.

The Locomotive Boiler

New England Railroad Club.—Meeting held November 4 at the Copley-Plaza Hotel, Boston, Mass. Paper by H. L. Miller, Republic Steel Corporation, entitled "The Thermal Expansion of the Locomotive Boiler and its relation to Failures of Material." ¶ Mr. Miller reviewed the development of the materials used in the construction of the modern locomotive boiler and firebox and gave considerable attention to the progress made in the design of staybolts, use of wrought iron, mild steel, nickel steel and various other alloys; boiler appliances such as Thermic syphons, Martin water tables, water tube fireboxes, superheaters, etc. He illustrated his paper with numerous charts showing the magnitude of the temperature and expansional stresses which cause the heavy repairs found necessary on many large locomotive boilers. ¶Mr. Miller's paper was discussed at considerable length, one of the speakers stating that the chemical composition of an alloy steel might be perfect from a metallurgical point of view and still not give satisfactory results, because the fabrication of steel and heat treatment are equally important with the chemical analysis.

Handling of Commodity Cards

Chicago Car Foremen's Association.—Meeting held at the Great Northern hotel, Chicago, Monday evening, December 8. Paper on the subject "Handling of Commodity Cards and Elimination of Oil and Grease Spots from the Floors of House Cars for High-Class Commodity Loading," by F. J. Swanson, district master car builder, Chicago, Milwaukee, St. Paul & Pacific, Minneapolis, Minn. ¶Mr. Swanson called attention in his paper to the necessity of furnishing clean, well-maintained equipment, in order to meet the keen competition now confronting the railways, and urged strongly the need of close co-operation between the operating and car department forces in this important work. He said that, while some railroads use commodity cards in the attempt to secure the proper classification of equipment, others do not and that a uniform practice, applicable to all roads, is desirable. Advantages of this practice, according to Mr. Swanson, include decreased switching costs, fewer empty car-miles, improved distribution of equipment and reduced storage of "rough" box cars. ¶ Referring to the general subject of the use of commodity cards, Mr. Swanson said: "One railroad has what is considered a very efficient and practical system of handling commodity cards and inspection. All empty cars coming from shop or repair tracks are inspected according to the class of lading for which they are fit, commodity cards being applied on each side of the car just below the car number. Empty cars received in train and interchange yards are likewise inspected and handled in the same manner, with the exception that, if cars arriving in train or interchange yards carry commodity cards less than 30 days old, they are not inspected outside of the regular running inspection. Any car carrying a commodity card over 30 days old is reinspected at the point inspected and a new commodity card applied as to what the car is fit for." ¶ The railroad mentioned uses nine different classification or commodity cards for house cars which inform station agents, yard-masters and others, where there are no car inspectors employed, what lading can be put in these cars without inviting damage claims. Mr. Swanson maintained that the introduction of such a system, accompanied by the proper classification of equipment, greatly reduces unnecessary car-miles now made by "rough" freight cars which can be put back in first-class service by simply sweeping or washing. He said that the proper application of commodity cards assists the transportation department in setting cars at different platforms and industries in accordance with the commodity to be loaded and has a tendency to prevent the costly practice, now all too prevalent, of loading products such as hides, oils, greases, paints and creosoted products in high-class equipment. Mr. Swanson's discussion regarding the methods of eliminating oil and grease spots will be given in full in later issue of the *Railway Mechanical Engineer.*

The Boiler Troubles Due to Feedwater

Western Railway Club.—Meeting held at the Hotel Sherman, Chicago, Monday evening, December 15. Paper presented on the subject "Feedwater and Its Relation to Boiler Troubles," by T. F. Powers, assistant superintendent of motive power and machinery, Chicago & North Western. ¶ Mr. Powers opened his paper by explaining that the primary purpose of a locomotive boiler is to generate steam and that the efficiency with which this is done depends upon many factors, the most important of which is the provision of feedwater free from large deposits of scale

(Continued on next left-hand page)

High Power 2-10-4 Type for the Santa Fe

DIMENSIONS AND WEIGHTS

Cylinders	30" x 34"
Drivers, diameter	69"
Steam pressure	300 lb.
Grate area	121.5 sq. ft.
Water heating surface	6114 sq. ft.
Superheating surface	2741 sq. ft.
Weight on drivers	349,910 lb.
Weight, total engine	502,260 lb.
Tractive force	93,000 lb.

ONE of the most notable locomotives recently built is shown in the above illustration—a trial engine of the 2-10-4 type, constructed for the Santa Fe System by these Works. As compared with the 2-10-2 type locomotives of the 3800 Class, which up to the present time have been the heaviest freight haulers on the road, the new locomotive presents an increase in starting tractive force of 14 per cent; in grate area of 37.5 per cent, and in combined heating surface of 34 per cent. Driving wheels 69 inches in diameter, as compared with the 63-inch wheels of the 3800 Class, give the new locomotive a marked advantage in speed capacity.

This new unit represents the characteristic features of the strictly modern locomotive—a machine of great ton-miles per hour capacity, which must eventually replace a large percentage of the power now in use if the railways are to adequately meet the transportation requirements of the future.

THE BALDWIN LOCOMOTIVE WORKS

PHILADELPHIA

and mud. He recalled the early days, before the present extensive scientific treatment of feedwater, when a reduction of locomotive failures, due to leaking boilers, to 50 a month was considered an excellent performance on the North Western. Today, millions of locomotive-miles are now being made by many railroads, with boiler failures occurring at very infrequent intervals. ¶ Mr. Powers said that in the past ten years the North Western has studied feedwater conditions extensively and that, on some divisions, most of the water supplied is treated in wayside plants which, in his opinion, provide the best and most satisfactory way of treating water. He said, however, that where the volume of business handled does not justify the investment in these plants, internal treatment is beneficial and the North Western is using the latter method extensively with good results. While much has been accomplished in reducing boiler failures on the road, Mr. Powers said that corrosion and pitting still presents a baffling problem and that "this form of boiler cancer is responsible for the expenditure of millions of dollars each year by American railroads. In some districts, it is not unusual to remove and scrap entire sets of flues because of pitting after nine to eighteen months' service....Locomotive boilers are pitting in districts today that, in former years, were free from this trouble." ¶Mr. Powers referred to the Gunderson electro-chemical method for the prevention of boiler corrosion, several applications of which are now favorably under test on the North Western, but said that its general application to locomotives in pitting districts cannot be decided upon until the expiration of these tests. Mr. Powers mentioned the use of alloy steel, protective coatings and excessive water treatment as possibly helping to solve the pitting problem, and discussed the embrittlement of boiler plate which, he thinks, with the proper water treatment, can be materially decreased, if not eliminated. ¶The closing paragraph in Mr. Powers' paper seems worth quoting in full: "I have tried in this paper to express from the viewpoint of a mechanical officer some of the difficulties experienced from improper feedwater and to outline in a general way what has been accomplished by improving it. Definite progress had been made; but there is still much to be accomplished. If improvement is to continue, it is necessary that close co-operation exist between the water engineers and other officers in the mechanical and other departments. It is important that mechanical department officers keep the water engineers constantly advised of difficulties existing in locomotive operation due to water troubles. Thus by the proper study of water conditions, they may be in a position to recommend to operating officers expenditures necessary and savings to be effected. In conclusion I wish to again emphasize that many of the troubles occurring in locomotive boilers can be materially reduced if proper feedwater is furnished. I feel that our managements now realize that the furnishing of proper feedwater to locomotives effects a real economy and is definite assurance of good operating conditions."

Directory

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—T. L. Burton, Room 5605 Grand Central Terminal building, New York.

AMERICAN RAILWAY ASSOCIATION.—DIVISION V.—MECHANICAL.—V. R. Hawthorne, 59 East Van Buren street, Chicago.
DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago.
DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey street, New York.
DIVISION I. — SAFETY SECTION. — J. C. Caviston, 30 Vesey street, New York.
DIVISION VIII.—CAR SERVICE DIVISION.—C. A. Buch, Seventeenth and H streets, Washington, D. C.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York.
RAILROAD DIVISION.—Paul D. Mallay, chief engineer, transportation department, Johns-Manville Corporation, 292 Madison avenue, New York.
MACHINE SHOP PRACTICE DIVISION. — Carlos de Zafra, care of A. S. M. E., 29 West Thirty-ninth street, New York.
MATERIALS HANDLING DIVISION.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.
OIL AND GAS POWER DIVISION.—L. H. Morrison, associate editor, Power, 475 Tenth avenue, New York.
FUELS DIVISION.—A. D. Black, associate editor, Power, 475 Tenth avenue, New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 7016 Euclid avenue, Cleveland, Ohio.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce street, Philadelphia, Pa

AMERICAN WELDING SOCIETY.—Miss M. M. Kelly, 29 West Thirty-ninth street, New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andrucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

ASSOCIATION OF RAILWAY SUPPLY MEN.—J. W. Fogg, MacLean-Fogg Lock Nut Company, 2649 N. Kildar avenue, Chicago. Meets with International Railway General Foremen's Association.

BOILER MAKER'S SUPPLY MEN'S ASSOCIATION.—Frank C. Hasse, Oxweld Railroad Service Company, 230 N. Michigan avenue, Chicago. Meets with Master Boiler Makers' Association.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2276 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month except in June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT OFFICERS ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 3001 West Thirty-ninth Place, Chicago, Ill. Regular meeting, second Monday in each month, except June, July and August, Great Northern Hotel, Chicago, Ill.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 608 South Main street, Los Angeles, Cal. Meetings second Monday of each month except July, August and September, in the Pacific Electric Club building, Los Angeles, Cal.

CAR FOREMAN'S ASSOCIATION OF OMAHA, Council Bluffs and South Omaha Interchange.—Geo. Kriegler, car foreman, Chicago, Burlington & Quincy, Sixteenth avenue and Sixth streets, Council Bluffs, Iowa. Regular meetings, second Thursday of each month at Council Bluffs.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—F. G. Weigman, 720 North Twenty-third street, East St. Louis, Ill. Regular meeting first Tuesday in each month, except July and August, at American Hotel Annex, St. Louis, Mo.

CENTRAL RAILWAY CLUB OF BUFFALO.—T. J. O'Donnell, 1004 Prudential building, Buffalo, N. Y. Regular meeting, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

CINCINNATI RAILWAY CLUB.—D. R. Boyd, 453 East Sixth street, Cincinnati. Regular meeting second Tuesday, February, May, September and November.

CLEVELAND RAILWAY CLUB.—F. L. Frericks, 14416 Adler avenue, Cleveland, Ohio. Meeting first Monday each month, except July, August and September, at Hotel Hollenden, East Sixth and Superior avenue.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS INTERCHANGE CAR INSPECTION ASSOCIATION.—E. A. Jackson, Box 22, Mail Room, Union Station, Indianapolis, Ind. Regular meetings first monday of each month at Hotel Severin, Indianapolis, at 7 p.m. Noon-day luncheon 12:15 p.m. for Executive Committee and men interested car department matters.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S SUPPLY MEN'S ASSOCIATION.—J. H. Jones, Crucible Steel Company, of America, 650 Washington boulevard, Chicago.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. T. Winkless, Room 707, LaSalle Street Station, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabash street, Winona, Minn.

INTERNATIONAL RAILWAY SUPPLY MEN'S ASSOCIATION.—W. J. Dickinson, acting secretary, 1703 Fisher building, Chicago. Meets with International Railway Fuel Association.

LOUISIANA CAR DEPARTMENT ASSOCIATION.—L. Brownlee, 3730 South Prieur street, New Orleans, La. Meetings third Thursday in each month.

MASTER BOILERMAKER'S ASSOCIATION. — A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—See Car Department Officers Association.

NATIONAL SAFETY COUNCIL—STEAM RAILROAD SECTION: W. A. Booth, Canadian National, Montreal, Que. William Penn and Fort Pitt Hotels, Pittsburgh, Pa.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meeting, second Tuesday in each month, excepting June, July, August and September. Copley-Plaza Hotel, Boston.

NEW YORK RAILROAD CLUB.—Douglas I. McKay, executive secretary, 26 Cortlandt street, New York. Meetings third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

PACIFIC RAILWAY CLUB.—W. S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

PUEBLO CAR MEN'S ASSOCIATION.—I. F. Wharton, chief clerk, Interchange Bureau, Pueblo, Colo.

RAILWAY BUSINESS ASSOCIATION. — Frank W. Noxon, 1124 Woodward building, Washington, D. C.

RAILWAY CAR MEN'S CLUB OF PEORIA AND PEKIN.—C. L. Roberts, chief clerk, Peoria & Pekin Union Railway, 217 Lydia avenue, Peoria, Ill.

RAILWAY CLUB OF GREENVILLE.—Paul A. Minnis, Bessemer & Lake Erie, Greenville, Pa. Meetings third Tuesday of each month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Regular Meeting fourth Thursday in month, except June, July and August. Ft. Pitt Hotel, Pittsburgh, Pa.

RAILWAY EQUIPMENT MANUFACTURERS' ASSOCIATION.—F. W. Venton, Crane Company, 836 South Michigan avenue, Chicago. Meets with Traveling Engineers' Association.

RAILWAY FIRE PROTECTION ASSOCIATION.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, American Railway Association.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, M. P. O. Drawer 24, St. Louis, Mo. Regular meetings, second Friday in each month, except June, July and August.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, June, September and November. Annual meeting third Thursday in November, Ansley Hotel, Atlanta, Ga.

SUPPLY MEN'S ASSOCIATION. — E. H. Hancock, treasurer, Louisville Varnish Company, Louisville, Ky. Meets with Equipment Painting Section, Mechanical Division, American Railway Association.

SUPPLY MEN'S ASSOCIATION.—Bradley S. Johnson, W. H. Miner, Inc., Chicago. Meets with Car Department Officers Association.

TRAVELING ENGINEERS' ASSOCIATION. — W. O. Thompson, 1177 East Ninety-eighth street. Cleveland, Ohio. Next convention March 25 to 28, 1931, Hotel Sherman, Chicago.

WESTERN RAILWAY CLUB.—W. J. Dickinson, 343 South Dearborn street, Chicago. Regular meetings, third Monday in each month, except June, July and August.

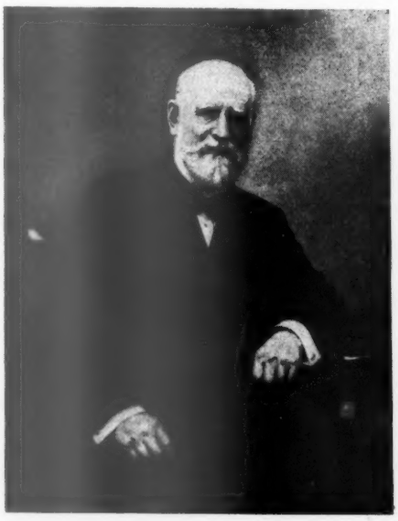
NEWS

Canadian National 4-6-4 Type Locomotives—A Correction

THE LIST of special equipment applied on the Canadian National 4-6-4 type locomotives, a description of which appeared in the December, 1930, *Railway Mechanical Engineer*, page 693, showed the grates as being of Hulson design. The grates applied to all five of these locomotives are of Canadian National standard design with reduced air openings.

The Bullard Company Commemorates Fiftieth Anniversary

IN COMMEMORATION of the fiftieth anniversary of the Bullard Company, established in 1880 by Edward Payson Bullard



Edward Payson Bullard, founder of the Bullard Company

as the Bridgeport Machine Tool Works, a portrait of the founder was hung in the main lobby of the new Bullard administration building on Canfield avenue, Bridgeport, Conn. Beneath the portrait is a bronze tablet inscribed with a sentiment indicative of the reverence with which Mr. Bullard's efforts and achievements are held by his successors. In 1894 the organization was incorporated as the Bullard Machine Tool Company and since 1929 has been known as The Bullard Company.

Born in 1841, Edward Payson Bullard at the age of 17 commenced serving an apprenticeship in the Whitins Machine Works, Whitinsville, Mass., at the completion of which he entered the employ of Colt's Armory at Hartford, Conn., subsequently becoming connected with the Pratt & Whitney Company.

After working for a number of years in the mechanical departments of the machinery business, he entered the merchandising field and, while being thus employed, established the Bridgeport Machine Tool Works. Lathes were the first products of this company, but the first big success came upon the adaption of the vertical boring mill principle to smaller unified machines of the vertical type. It was thus that the basic principles for the present Bullard production machines were laid.

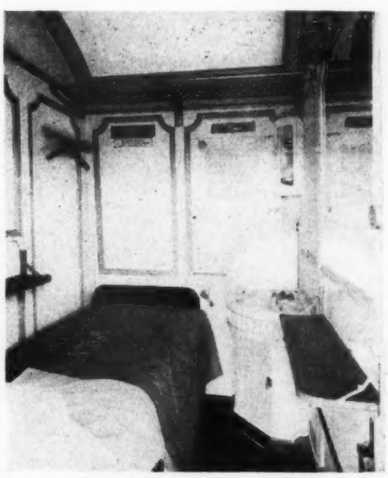
Before the death of the founder in 1906, he submitted to his engineers the basic design of the Bullard automatic multiple production equipment, having foreseen the possibility of automatic multiple production in the machine field. The new design adhered naturally to the vertical principle and was essentially six complete machines in one, each unit complete in itself and subject to individual adjustment in order that it might meet the varying conditions of operation which it would perform. The final result of the basic design was the building of the Bullard Mult-Au-Matic and the Bullard Contin-U-Matic vertical turret lathes.

Group picture of Bullard employees taken in 1887

New Sleeping Cars for L. N. E. of Great Britain

THE LONDON & NORTH EASTERN of Great Britain has recently placed in service several new sleeping cars, embodying many new features of interior design and decoration. These new cars, recently constructed by the L. N. E., include complete departures from previous practices.

Among the more important new features introduced is the painting of the interiors. Until recently, polished wood was used almost exclusively in the interior decoration of British sleeping car berths. The colors have been so chosen that each compartment, which is fitted with a regular bed, has the appearance of a small well-appointed bedroom. The floor is covered with Persian design close covered carpet having a ground of dark blue; the corridor is covered with similar carpet having a line border all around. Hot and cold water is supplied to each compartment which has a wash bowl fitted in the corner near the window. A large mirror is placed centrally on the intermediate partition and a full length mirror is fixed on the door leading to the corridor. A folding table is provided on the intermediate partition and another one to take a tea tray is placed over the bed. A shelf is fitted over the bed head.



Interior of compartment as seen from corridor

The lighting is provided by a 30-watt opal lamp carried in a special fitting in the centre of the ceiling; a reading lamp is included under the shelf over the bed head. There is also a lamp enclosed in a silk shade on the partition over the mirror. A steam-heat radiator is provided on the partition below the mirror, the regulator controlling it being placed near the bed head. In addition to the ventilation provided by means of window and extractor ventilators, the car is fitted with pressure ventilation. The air supplied to each berth is drawn through a filter by a noiseless electric blower fan at one end of the corridor. A toilet compartment is provided at one end of the corridor. The attendant's compartment is at the opposite end of the car, and is

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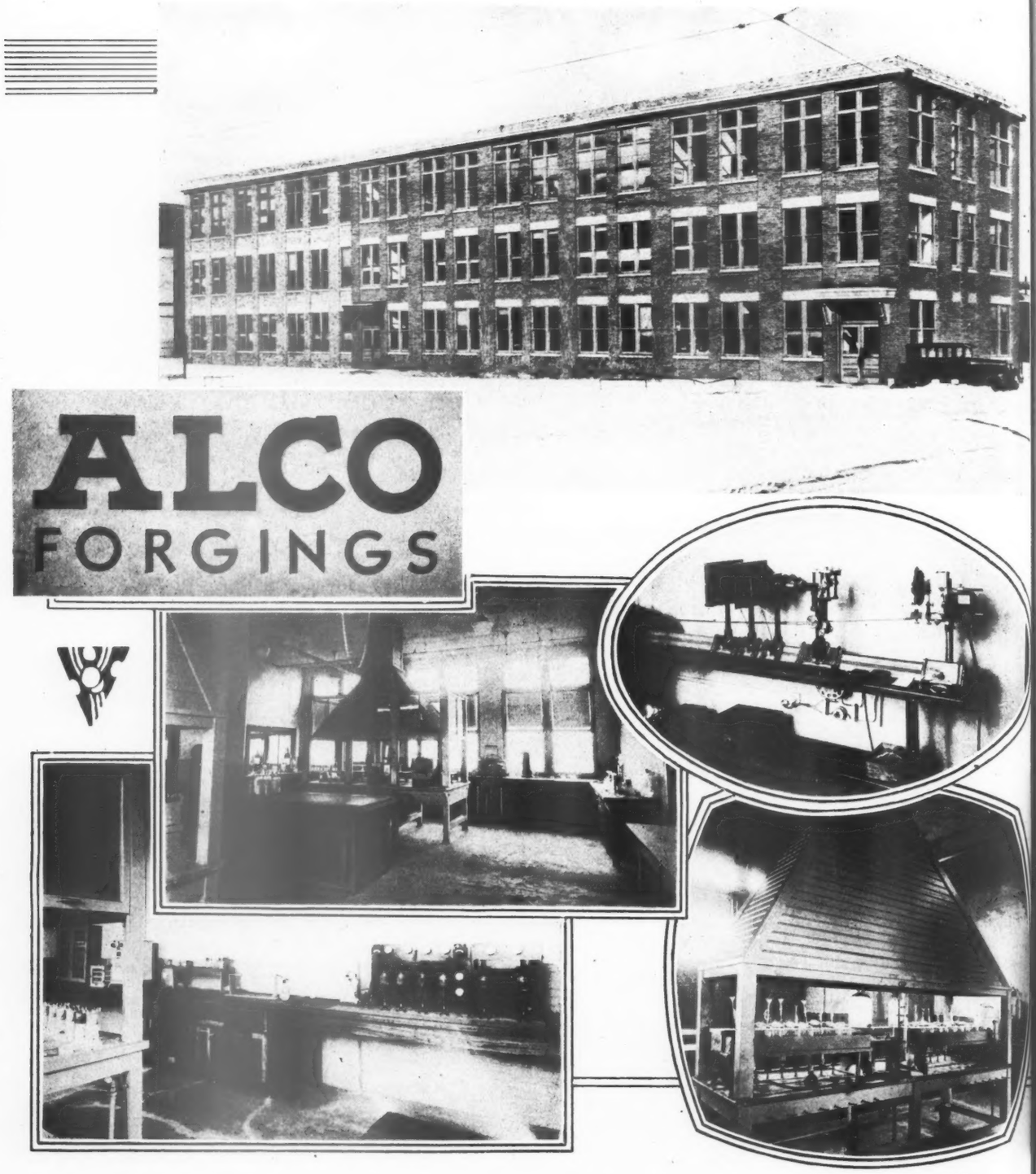


AMERICAN LOCO
30 CHURCH STREET

TO confer the identity of long life under hard service conditions on Alco forgings, the first essential requirement is the selection of the raw material. We go much further than just making sure that the producer of the billet is a quality manufacturer.

We employ a corps of mill inspectors who have had years of experience in the inspection of locomotive materials. These men inspect and test the billets or ingots at the mill.

A very careful surface examination is made.

Drillings are taken from all heats — such samples being taken from at least six different billets representing different localities in the ingot. These drillings are forwarded to our laboratory where complete chemical determinations are made before the billets are released for shipment. In addition to the usual analysis made at a point half way between center and edge, we make a complete analysis from drilling taken at the dead center of the billet. This enables us to make certain that the material is free from segregation.

All heats of high carbon steel are subjected to a tensile test. This test gives an excellent indication as to the physical properties of the steel and the soundness thereof.

In the case of alloy steels, a full section macroscopic test is made from samples taken to represent billets from different portions of the ingot. These macro tests give indication as to the soundness of the material. We believe that this deep-etch test is the only one that will detect thermal ruptures produced during casting, reheating or blooming mill work—defects which we know are responsible for many failures in the alloy steels.

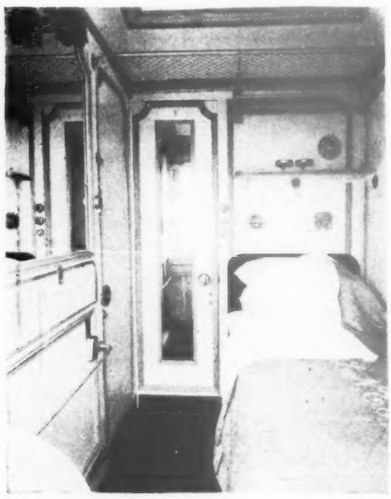
We have long recognized that to insure the best in quality requires much more than the mere writing of a specification.

Alco forgings will multiply the utility and economy of your motive power both old and new.

MOTIVE COMPANY
NEW YORK CITY

fitted with the necessary cupboards for crockery, sink, etc., to enable light refreshments to be served. The apparatus for supplying hot water to the berths is also included in the attendant's compartment and forms one of the principal features of the car. The water is heated by electricity, and thereby it has been possible to dispense entirely with gas.

The cars are built of teak, and special



View of compartment looking toward door

attention has been paid to the elimination of noise. The body itself is carried on India rubber pads insulating it from the steel frame, and compressed "Wadnit" asbestos felt has been placed between the upper and lower courses of the double floors. The same felt is also used to fill in all space between the inner and outer roof and body sides. The floors are covered with sponge rubber half an inch thick under the carpets.

The overall length of each car is 63 ft. 6 in., the body being carried on a steel underframe mounted on two standard L.N.E.R. four-wheel compound-bolster 8 ft. 6 in. wheelbase trucks. Pullman vestibules are also included.

Supply Trade Notes

I. L. WARD has been appointed Pacific Coast representative for the Union Railway Equipment Company, with office at 503 Market street, San Francisco, Cal.

THE CENTRIFIX CORPORATION, CLEVELAND, Ohio, has appointed the Wyman Engineering Sales Company, Cincinnati, Ohio, its representative in the Cincinnati district.

THE GENERAL MOTORS CORPORATION, Detroit, Mich., has purchased the Electro-Motive Company, Cleveland, Ohio, and will operate the latter as a separate company with the same personnel.

PAUL LLEWELLYN, formerly president of the Interstate Iron & Steel Company, Chicago, has recently been elected to serve as the chairman of the board of the Empire Steel Corporation, Mansfield, Ohio.

OWEN H. PERSONS, assistant manager of sales of the American Steel & Wire Co., with headquarters at Philadelphia, Pa., has resigned to become general manager of sales of the Edgecomb Steel Company, offices at Philadelphia.

THE GENERAL OFFICE of E. I. du Pont de Nemours & Co., of which A. E. Pratt is manager, and the eastern office, of which F. H. Crawford is manager of the transportation sales department, have been moved from Parlin, N. J., to 1616 Walnut street, Philadelphia, Pa. The transportation sales department handles the sale of Duco, Dulux and paint and varnish products to steam railroads, electric railways and the marine industry. No change has been made in the New York and Chicago offices.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY plans to make improvements to cost over $300,000 at its South Philadelphia, Pa., works. The company contemplates alterations and additions to include the conversion of part of the manufacturing space into a new shop, where all locomotive equipping and testing activity in connection with Westinghouse oil-electric and electric locomotives will be concentrated. The plans also call for laying one and one-half miles of additional railroad track involving the handling of more than 12,000 cu. yd. of material in connection with new construction within the plant area; in connection with the Pennsylvania Railroad and the City of Philadelphia, the electrification, relocation and regrading of four miles of trackage to be used as a high-speed test track will be carried out.

Obituary

WALTER ROSS GRAVENER, southeastern sales manager of the American Steel Foundries, Washington, D. C., died on November 21. Mr. Gravener was born on January 25, 1872 at Ludlow, Ky., and was educated in Palatka, Fla., public schools. He began work as clerk in the office of the superintendent of motive power on the Plant System Railroad,

Walter Ross Gravener

(now a part of the Atlantic Coast Line) about 1890. He left the Plant System in 1900 and became associated with the American Steel Castings Company at New York. In the formation of the American Steel Foundries about 1903, the American Steel Castings Company was included and Mr. Gravener became associated with the American Steel Foundries as salesman in the New York office. He moved to Washington in 1905 and opened the office there as sales agent handling the southeastern territory. Mr. Gravener was appointed southeastern sales manager in November, 1929.

JAMES A. MURRAY, eastern manager of the Ajax Manufacturing Company of Cleveland, Ohio, died on December 23.

HENRY HARNISCHFEGER, president of the Harnischfeger Corporation, Milwaukee, Wis., died on November 15.

A. W. WILLCUTS, assistant manager of the railroad sales department of Joseph T. Ryerson & Son, Inc., with headquarters at St. Louis, Mo., died on December 14 from heart failure.

(*Continued on second left-hand page*)

Domestic Orders Reported During December, 1930

Locomotives

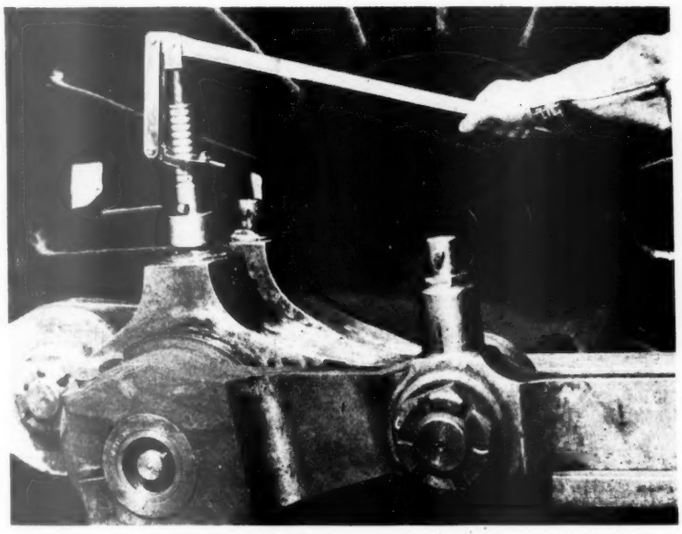
Name of Company	Number ordered	Type	Builder
Reading	10	2-10-2	Baldwin Loco. Wks.
New York Central	40	4-6-4	American Loco. Wks.
	10	4-6-4	Lima Loco. Wks.
Total for December, 1930	60		

Freight Cars

Carnegie Steel Company	30	Gondola	American Car & Fdy.
	20	Flat	Pressed Steel Car Co.
	18	Flat	Standard Steel Car Corp.
Atchison, Topeka & Santa Fe	500	Refrigerator	Pullman Car & Fdy.
	350	Box	Pressed Steel Car Co.
	300	Box	General American Car
	300	Box	American Car & Fdy.
Missouri-Kansas-Texas	25	Caboose	Company Shops
City of Chicago	1	Hopper	Mt. Vernon Car Mfg.
North American Car Corporation	50	Refrigerator	Company Shops
Atchison, Topeka & Santa Fe	22	Caboose	American Car & Fdy.
	50	Box	General American Car
Sanitary District of Chicago	25	Dump	Western Wheeled Scraper Co.
Total for December, 1930	1691		

Passenger Cars

Atchison, Topeka & Santa Fe	2	Cafe	Pullman Car & Mfg. Corp.
Total for December, 1930	2		



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NEW ORLEANS, LA.

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Consolidated Equipment Company, Montreal
Mumford Medland, Ltd., Winnipeg
International Railway Supply Company, 30 Church St., New York City

Saves Time, Labor, Grease and Grease Plugs

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Personal Mention

General

R. W. Brown, general superintendent of the eastern lines of the Baltimore & Ohio, has been appointed general manager of the Central of New Jersey, with headquarters at Jersey City, N. J. Mr. Brown was born on August 5, 1883, at

R. W. Brown

Carlyle, Ill., and was educated in the elementary schools of that city. He began railroad service as a laborer on the Baltimore & Ohio in July, 1901, becoming a fireman in 1902 and engineman in 1905; then air brake instructor and in 1910, assistant road foreman of engines. In January, 1914, he was appointed supervisor, locomotive operation; in June, 1915, trainmaster, and in October, 1917, assistant superintendent. He became superintendent of the Ohio division at Chillicothe, Ohio, in September, 1919; in October, 1921, was transferred to the Connellsville division, and in June, 1923, transferred to the Cumberland division in the same capacity. In January, 1926, he was appointed general superintendent of the eastern lines of the Baltimore & Ohio.

C. M. Shriver, superintendent of Baltimore terminals, of the Baltimore & Ohio,

C. M. Shriver

has been appointed superintendent of the Baltimore division. Mr. Shriver, who was born in Baltimore, Md., on January 9, 1893, and received his education in the Boys Latin School at Baltimore, and at Lehigh University, entered railway service in 1912, as a machinist apprentice with the Baltimore & Ohio. In July, 1915, he was appointed machinist and from January to April, 1916, he served in the capacity of inspector of fuel service. He became assistant road foreman of engines in April, 1916; in March, 1917, assistant trainmaster, and in May, 1917, trainmaster. From July, 1918, to May, 1919, Mr. Shriver was furloughed for military service, returning to the B. & O. as trainmaster in 1919. In July, 1920, he was appointed assistant superintendent of the Baltimore terminals, and in 1921, superintendent.

Michael A. Smith, superintendent of motive power of the Pittsburgh & Lake Erie and Lake Erie and Eastern, has been appointed general manager. Mr. Smith was born in Norwalk, Ohio, on September 7, 1872, and was educated in the public schools of Norwalk. He entered the service of the Wheeling & Lake Erie as a locomotive fireman on August 29, 1890, and was advanced to locomotive engineer

Michael A. Smith

in 1896. Mr. Smith left the service of the Wheeling & Lake Erie in 1899, and in March, 1900, entered the service of the Pittsburgh & Lake Erie as a locomotive inspector, serving in that capacity until June, 1901. From the latter date until November, 1902, he was traveling fireman, and then served as enginehouse foreman until June, 1904. Mr. Smith then became general foreman at the Glassport shops which position he held until December, 1912, when he was transferred in the same capacity to the East Youngstown shops, where he remained until September, 1917. From September, 1917, until June, 1923, he served as trainmaster, and in September, 1927, became assistant superintendent of motive power.

Harry L. Worman, superintendent of motive power of the St. Louis-San Francisco, with headquarters at Springfield, Mo., has been elected vice-president in charge of operation, with headquarters at St. Louis, Mo. Mr. Worman has been in railway service for 32 years, 25 of which have been in the mechanical department of the Frisco. He was born at Salem, Ohio, on July 19, 1881, and obtained his first railroad experience as an enginehouse helper on the Kansas City Southern at Kansas City, Mo., in 1898. Later in the same year he became a machinist

Harry L. Worman

apprentice and in 1902 was advanced to machinist, leaving the Kansas City Southern in 1903 to become a pressman for the Kansas City Star. He entered Frisco service in 1905 as a machinist at Kansas City, then serving successively on that road as enginehouse foreman at Kansas City, erecting foreman, machine foreman and general foreman at Scott, Kan., and traveling enginehouse foreman and master mechanic at Memphis, Tenn. In 1919 Mr. Worman was promoted to the position of assistant superintendent of motive power, with headquarters at Springfield, his promotion to superintendent of motive power becoming effective in November, 1920.

Karl Berg, who has been appointed superintendent of motive power of the

Karl Berg

Pittsburgh & Lake Erie and Lake Erie & Eastern, as announced in the December issue of the *Railway Mechanical Engineer*, was born in Sweden in December, 1881. He was educated in the public schools of Sweden and attended the New York Central apprentice school while serving as an apprentice. After completing the ap-

(Continued on next left-hand page)